
CHARACTERIZATION AND MONITORING PROGRAM

The purpose of the Characterization and Monitoring Program (CaMP), formerly the Monitoring and Measurement Technologies Program (MMTP), is to accelerate the development, demonstration, and use of innovative monitoring, measurement, and characterization technologies at Superfund sites. These technologies are used to assess the nature and extent of contamination and evaluate the progress and effectiveness of remedial actions. The CaMP places high priority on technologies that provide cost-effective, faster, and safer methods than conventional technologies for producing real-time or near-real-time data.

The CaMP is interested in new or modified technologies that can detect, monitor, and measure hazardous and toxic substances in the surface (soil and sediment), subsurface (saturated and vadose zones), air, biological tissues, wastes, and surface waters, as well as technologies that characterize the physical properties of sites. Technologies of interest include chemical sensors for in situ measurements; groundwater sampling devices; soil and core sampling devices; soil gas sampling devices; fluid sampling devices for the vadose zone; in situ and field-portable analytical methods; and other systems that support field sampling or data acquisition and analysis.

The identification of candidate technologies is ongoing; therefore, technology developers are encouraged to submit new and updated information at any time. This information is reviewed, cataloged, and incorporated into a technology matrix, from which EPA makes a preliminary determination of possible candidates for participation. Developers interested in participating should contact Stephen Billets at 702-798-2232.

Evaluations or demonstrations have been completed for 31 projects in the CaMP. These technologies are presented in alphabetical order in Table 4 and are included in the technology profiles that follow.

TABLE 5
Completed SITE Characterization and Monitoring Program Projects as of December 1996

Developer	Technology	Technology Contact	EPA Project Manager	Applicable Media	Applicable Waste	
					Inorganic	Organic
Analytical and Remedial Technology, Inc., Milpitas, CA	Automated Sampling and Analytical Platform	Gary Hopkins 408-263-8931	Stephen Billets 702-798-2232	Aqueous Samples	Nonspecific Inorganics	VOCs, PAHs, Ionizable Organics
Bruker Analytical Systems, Inc., Billerica, MA	Mobile Environmental Monitor	John Wronka 508-667-9580	Stephen Billets 702-798-2232	Air Streams, Water, Soil, Sludge, Sediment	Not Applicable	VOCs, SVOCs, PCBs, PAHs
Dexsil Corporation, Hamden, CT (Two Demonstrations)	Environmental Test Kits	Jack Mahon 203-288-3509	Stephen Billets 702-798-2232	Soil, Sediment, Transformer Oils	Not Applicable	PCBs
Environmental Technologies Group, Inc.	AirSentry Fourier Transform Infrared Spectrometer	Not Available	William McClenny 919-541-3158	Air Streams	Nonspecific Inorganics	Nonspecific Organics
Fugro Geosciences, Inc., (formerly Loral Corporation), Houston, TX	Rapid Optical Screening Tool	Andrew Taer 800-75FUGRO	Eric Koglin 702-798-2432	Soil	Not Applicable	Petroleum, PAHs, VOCs
Geoprobe Systems, Salina, KS	Geoprobe Soil Conductivity Sensor	Colin Christy Troy Schmidt 913-825-1842	Stephen Billets 702-798-2232	Soil, Rock, Hydrogeologic Fluids	Nonspecific Inorganics	Nonspecific Organics
Graseby Ionics, Ltd., and PCP, Inc., Watford, Hertsfordshire, England/West Palm Beach, FL (Two Demonstrations)	Ion Mobility Spectrometry	John Brokenshire 011-44-1923-816166 Martin Cohen 561-683-0507	Eric Koglin 702-798-2432	Air Streams, Vapor, Soil, Water	Not Applicable	VOCs
Hanby Environmental Laboratory Procedures, Inc., Wimberley, TX	Test Kits for Organic Contaminants in Soil and Water	John Hanby 512-847-1212	Eric Koglin 702-798-2432	Soil, Water	Not Applicable	PCP, PAHs, Other Various Organics
HNU Systems, Inc., Newton, MA	HNU Source Excited Fluorescence Analyzer-Portable (SEFA-P) X-Ray Fluorescence Analyzer	Jack Driscoll 800-724-6690 617-964-6690	Stephen Billets 702-798-2232	Solids, Liquids, Slurries, Powders	Metals	Not Applicable

TABLE 5 (Continued)
Completed SITE Characterization and Monitoring Program Projects as of December 1996

Developer	Technology	Technology Contact	EPA Project Manager	Applicable Media	Applicable Waste	
					Inorganic	Organic
HNU Systems, Inc., Newton, MA	HNU GC 311D Portable Gas Chromatograph	Jack Driscoll 800-724-6690 617-964-6690	Richard Berkley 919-541-2439	Air Streams	Not Applicable	VOCs, Aromatic Compounds, Halocarbons, PCBs
Idetek, Inc. (formerly Binax Corporation, Antox Division), Sunnyvale, CA	Equate® Immunoassay	Richard Lankow 408-752-1353	Jeanette Van Emon 702-798-2154	Water	Not Applicable	Benzene, Toluene, Xylene
Metorex, Inc., Bend, OR	Field Portable X-Ray Fluorescence Analyzers	James Pasmore 800-229-9209 541-385-6748	Stephen Billets 702-798-2232	Soil, Water	Metals	Not Applicable
Microsensor Systems, Incorporated, Bowling Green, KY	MSI-301A Vapor Monitor	Norman Davis 502-745-0099	Richard Berkley 919-541-2439	Air Streams	Not Applicable	VOCs
Millipore Corporation, Bedford, MA	EnviroGard™ PCB Immunoassay Test Kit	Barbara Young 617-533-5207	Stephen Billets 702-798-2232 Jeanette Van Emon 702-798-2154	Soil, Sediment	Not Applicable	PCBs
Millipore Corporation, Bedford, MA	EnviroGard™ PCP Immunoassay Test Kit	Barbara Young 617-533-5207	Jeanette Van Emon 702-798-2154	Soil, Water	Not Applicable	PCP
MTI Analytical Instruments (formerly Microsensor Technology, Incorporated), Fremont, CA	Portable Gas Analyzer	David Sherve 510-490-0900	Richard Berkley 919-541-2439	Air Streams, Soil Gas	Nonspecific Inorganics	VOCs
Naval Command, Control, and Ocean Surveillance Center, San Diego, CA	SCAPS Cone Penetrometer	Thomas Hampton 619-553-1172	Bob Lien 708-798-2232	Soil	Not Applicable	Petroleum Hydrocarbons
NITON Corporation, Bedford, MA	XL Spectrum Analyzer	Stephen Shefsky 617-275-9275	Stephen Billets 702-798-2232	Soil	Metals	Not Applicable
Photovac Monitoring Instruments (formerly Photovac International, Inc.) Deer Park, NY	PE Photovac Voyager Portable Gas Chromatograph	Mark Collins 516-254-4199	Richard Berkley 919-541-2439	Air Streams	Not Applicable	VOCs

TABLE 5 (Continued)
Completed SITE Characterization and Monitoring Program Projects as of December 1996

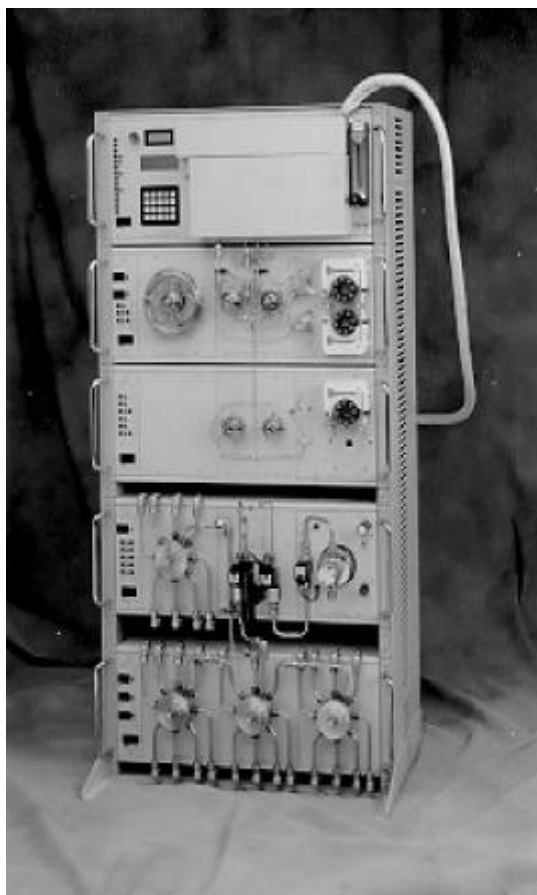
Developer	Technology	Technology Contact	EPA Project Manager	Applicable Media	Applicable Waste	
					Inorganic	Organic
SCITEC Corporation, Kennewick, WA	Metal Analysis Probe (MAP®) Portable Assayer	Steve Santy 800-466-5323 509-783-9850	Stephen Billets 702-798-2232	Soil, Sediment, Filter and Wipe Samples	Nonspecific Metals, Lead	Not Applicable
Sentex Systems, Inc., Ridgefield, NJ	Scentograph Plus II Portable Gas Chromatograph	Amos Linenberg 201-945-3694	Richard Berkley 919-541-2439	Air Streams	Not Applicable	VOCs
SRI Instruments, Torrance, CA	Compact Gas Chromatograph	Douglas Gavilanes 310-214-5092	Richard Berkley 919-541-2439	Air Streams, Soil, Water	Not Applicable	VOCs, BTEX, PCBs, Pesticides
Strategic Diagnostics, Inc., (formerly EnSys Environmental Products, Inc., Newtown, PA (Two Demonstrations)	PENTA RISc Test System	Tim Lawruk 800-544-8881 215-860-5115	Jeanette Van Emon 702-798-2154	Soil, Water	Not Applicable	PCP
Strategic Diagnostics, Inc., (formerly Ohmicron Corporation), Newtown, PA	RaPID Assay®	Craig Kostyshyn 215-860-5115, ext. 634	Jeanette Van Emon 702-798-2154	Soil, Water	Not Applicable	PCP
TN Spectrace Round Rock, TX	TN 9000 and TN Pb X-Ray Fluorescence Analyzers	Raj Natrajan 512-388-9100	Stephen Billets 702-798-2232	Soil, Sediment, Filter and Wipe Samples	Metals, Lead	Not Applicable
Tri-Services, Aberdeen Proving Ground, MD	Site Characterization and Analysis Penetrometer System (SCAPS)	George Robitaille 410-612-6865 John Ballard 601-634-2446	Stephen Billets 702-798-2232	Soil	Not Applicable	Petroleum, PAHs, VOCs
United States Environmental Protection Agency, Washington, D.C.	Field Analytical Screening Program PCB Method	Howard Fribush 703-603-8831	Eric Koglin 702-798-2432	Soil, Water	Not Applicable	PCBs
XonTech Incorporated, Van Nuys, CA	XonTech Sector Sampler	Matt Yoong 818-787-7380	Joachim Pleil 919-541-4680	Air Streams	Not Applicable	VOCs

**ANALYTICAL AND REMEDIAL
TECHNOLOGY, INC.**
(Automated Sampling and Analytical Platform)

TECHNOLOGY DESCRIPTION:

Analytical and Remedial Technology, Inc. (A⁺RT), produces components that can be assembled in various configurations to allow automated sampling and analysis of water streams. The A⁺RT components are mounted in a custom case to produce an automated sampling and analytical platform (ASAP). A complete ASAP system consists of the following basic components:

- An ASAP sampling manifold module with internal pump
- An optional module to allow the ASAP to control up to 48 Grundfos 2-inch submersible pumps



Automated Sampling and Analytical Platform

- One or more ASAP sample preparation modules
- One or more third-party gas or liquid chromatographs with appropriate detectors
- One or more third-party integrators for processing raw data and producing hard copies of chromatograms
- A Windows 3.X-compatible microcomputer running A⁺RT software to control the system, store results in a database, and provide telecommunication capabilities

The photograph below illustrates an ASAP configured for automated sampling of 29 points using 0.25-inch stainless steel tubing. The A⁺RT purge-and-trap concentrator draws a precise volume of water (selectable from 0.2 to 10 milliliters) from the selected sample stream and prepares it for volatile organic compound (VOC) analysis using a gas chromatograph. The A⁺RT concentrator differs from the customary batch purging approach in that it uses a flow-through, countercurrent stripping cell.

The A⁺RT high performance liquid chromatograph (HPLC) sample preparation module collects a sample in a fixed volume loop and delivers it to the HPLC. With additional components, the module can support a second channel for HPLC analysis along with either automated or manual sample selection. The module can also be configured to process the samples using solid-phase extraction. This process concentrates analytes, which are then backflushed with solvent and extracted for subsequent HPLC analysis.

An optional Grundfos pump interface module (GPIM) allows the ASAP, for a given sample, to select and operate one of up to 48 Grundfos RediFlo-2™ 2-inch submersible pumps connected to the ASAP. Thus, this module allows automatic sampling of groundwater for groundwater depths greater than 15 to 20 feet below surface. Control of up to 48 pumps requires only one Grundfos MP1 controller interfaced with the GPIM.

The A⁺RT components and software are designed to allow continuous (24-hour) monitoring for long periods of time (months to years) with automated continuing calibration checks and recalibration when necessary. The ASAP is designed to be installed with the other system components permanently or semipermanently in a secure, temperature-controlled space on site.

WASTE APPLICABILITY:

The ASAP is designed for automated sampling and analysis of aqueous samples, such as those obtained from a treatment or process stream or from wells emplaced in a groundwater contaminant plume. The ASAP can be configured for a wide variety of contaminants, including VOCs, polynuclear aromatic hydrocarbons, ionizable organic chemicals, and a range of inorganic substances.

STATUS:

Several commercial ASAP systems have been purchased by universities for use in groundwater remediation research at U.S. Department of Defense facilities. The ASAP has considerably broader capabilities than the prototype system (the Automated Volatile Organics Analytical System, or AVOAS) evaluated under the SITE Program. The AVOAS was demonstrated in May 1991 at the Wells G and H Superfund site in EPA Region 1. The results of the demonstration have been published by EPA ("Automated On-Site Measurement of Volatile Organics in Water," EPA/600/R-93/109, June 1993).

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BRUKER ANALYTICAL SYSTEMS, INC.
(Mobile Environmental Monitor)

TECHNOLOGY DESCRIPTION:

The Bruker Analytical Systems, Inc. (Bruker), mobile environmental monitor (see photograph below) is a field-transportable, gas chromatography/mass spectrometer (GC/MS) designed to identify and measure organic pollutants in various environmental media. The MS uses a quadrupole mass analyzer similar to most conventional instruments. Like conventional MSs, this instrument can identify and quantify organic compounds on the basis of their retention time, molecular weight, and characteristic fragment pattern. The integrated GC allows introduction of complex extracts for separation into individual components and subsequent analysis in the MS.

The Bruker instrument's design and electronics are specially designed for field use. The instrument is

designed to operate with battery power and can be used in various environmental situations with minimum support requirements.

The mobile environmental monitor was originally designed for the military to detect and monitor chemical warfare agents. Environmental samples may be introduced to the MS through the direct air sampler or the GC. Results are collected and stored in a computer, where data is reduced and analyzed. The computer provides reports within minutes of final data acquisition.

WASTE APPLICABILITY:

The Bruker mobile environmental monitor is designed to detect the full range of volatile and semivolatile organic compounds directly in air and in water, soil, sediment, sludge, and hazardous waste extracts. It provides in-field, real-time



Brunker Mobile Environmental Monitor

support during the characterization and remediation phases of cleanup at a hazardous waste site.

STATUS:

This technology was demonstrated at the Re-Solve, Inc., and Westborough Superfund sites in EPA Region 1. The technology was used to analyze polychlorinated biphenyls and polynuclear aromatics in soil and the full range of Superfund-targeted volatile organic compounds in water. Splits of all samples analyzed in the field were shipped to a laboratory for confirmatory analysis using standard EPA analytical methods.

The SITE demonstration was completed in September 1990, and the final report (EPA/600/X-91/079) is available from EPA. The results of this study were presented at the American Society for Mass Spectrometry Conference in May 1991 and at the Superfund Hazardous Waste Conference in July 1991. A recent survey of regional laboratories identified additional testing of this technology as a priority need.

Bruker has developed an additional system that addresses recommendations made in the project report. This system, designated the EM640, has increased mass range, decreased power consumption, faster sample analysis, and automated report generation. The EM640 was demonstrated under the SITE Program in July and September 1995.

The Environmental Monitoring Systems Laboratory-Las Vegas purchased a Bruker mobile environmental monitor in fiscal year 1992 to pursue other applications and to expand the scope of this project.

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DEXSIL CORPORATION (Environmental Test Kits)

TECHNOLOGY DESCRIPTION:

The Dexsil Corporation (Dexsil) produces two test kits that detect polychlorinated biphenyls (PCB) in soil: the Dexsil Clor-N-Soil PCB Screening Kit, and the Dexsil L2000 PCB/Chloride Analyzer. The Dexsil Clor-N-Soil PCB Screening Kit, (see photograph below) extracts PCBs from soil and dissociates the PCBs with a sodium reagent, freeing chloride ions. These ions then react with mercuric ions to form mercuric chloride. The extract is then treated with diphenylcarbazone, which reacts with free mercuric ions to form a purple color. The less purple the color, the greater the concentration of PCBs in the sample.

The Dexsil L2000 PCB/Chloride Analyzer (see photograph on next page) also extracts PCBs from soil and dissociates the PCBs with a sodium reagent,

freeing chloride ions. The extract is then analyzed with a calibrated, chloride-specific electrode. The L2000 instrument then translates the output from the electrode into parts per million (ppm) PCB.

These kits produce analytical results at different data quality levels. The Dexsil Clor-N-Soil PCB Screening Kit identifies samples above or below a single concentration, which is generally tied to regulatory action levels. The Dexsil L2000 PCB/Chloride Analyzer quantifies specific concentrations of PCBs, from 2 to 2,000 ppm, in a sample. The applicability of these methods depends on the data quality needs of a specific project. Both technologies can be used on site for site characterization or a removal action.

WASTE APPLICABILITY:



Dexsil Clor-N-Soil PCB Screening Kit

The Dexsil Clor-N-Soil PCB Screening Kit and the Dexsil L2000 PCB/Chloride Analyzer can detect PCBs in soil, sediment, and transformer oils.

STATUS:

These test kits were demonstrated at a PCB-contaminated facility in EPA Region 7. About 200 soil samples were collected and analyzed on site using the Dexsil test kits. Soil samples were not dried prior to analysis. Split samples were submitted to an off-site laboratory for confirmatory analysis by SW-846 Method 8080. Demonstration data were used to evaluate the accuracy and precision of the test kits relative to internal quality control samples and to formal laboratory data. These data were also used to determine operating costs.

The sampling and field analyses for this technology demonstration were completed in August 1992. The Innovative Technology Evaluation Report (EPA/540/R-95/518) is available from EPA. The Office of Solid Waste has designated the L2000 Method for PCB screening of soil as Method 9078, to be included in the third update to the third edition

of SW-846.

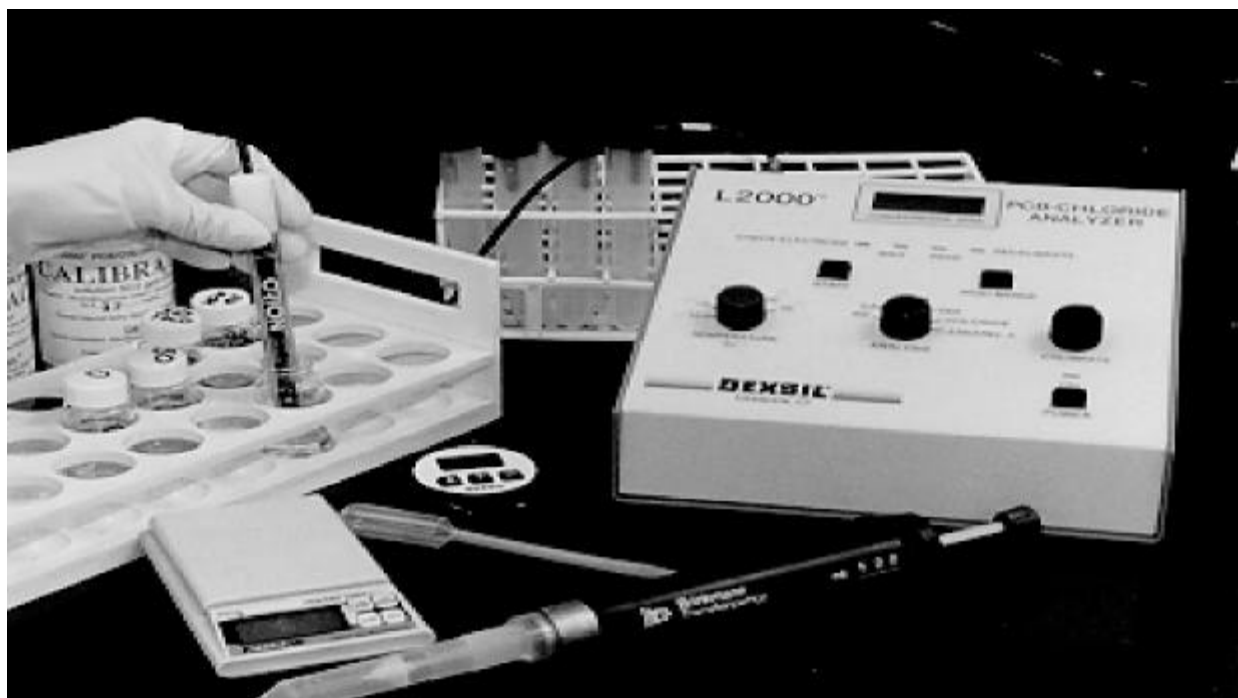
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Dexsil L2000 PCB/Chloride Analyzer

ENVIRONMENTAL TECHNOLOGIES GROUP, INC.
(AirSentry Fourier Transform Infrared Spectrometer)

TECHNOLOGY DESCRIPTION:

This air monitoring system (see photograph below) is a field-deployable, open-path Fourier transform infrared (FTIR) spectrometer that measures infrared absorption by infrared-active molecules. The spectrometer system transmits an infrared beam along an open air path to a retroreflector target that returns it to the spectrometer. The total air path can be up to 1 kilometer long. Analysis is performed using a quantitative reference spectrum of known concentration, together with classical least squares data fitting software routines. The system does not require acquisition of an air sample; this factor enhances data integrity by eliminating the potential for error inherent to many air sampling techniques.

A measurement over several hundred meters requires only a few minutes, which allows determination of temporal profiles for pollutant gas concentrations. The spectrometer requires performance verification procedures, but does not require calibration.

WASTE APPLICABILITY:

The AirSentry FTIR spectrometer can measure various airborne vapors, including both organic and inorganic compounds, especially those that are too volatile to be collected by preconcentration methods. It can be used to monitor emissions from hazardous waste sites during remediation and removal.



AirSentry Fourier Transform Infrared Spectrometer

STATUS:

The AirSentry FTIR spectrometer was demonstrated during a 1990 SITE study at Shaver's Farm, a Superfund site in northwest Georgia. The purpose of this demonstration was to test performance during remedial activities and to develop and test on-site quality assurance procedures. Results of this study were published in a paper titled "Use of a Fourier Transform Spectrometer As a Remote Sensor at Superfund Sites," presented at a 1991 conference.

The AirSentry FTIR spectrometer has been evaluated in several other field studies and has been proven capable of detecting various airborne atmospheric vapors. The AirSentry FTIR gas analysis software, which automatically identifies and quantifies compounds in the presence of background interferences, was evaluated in a 1991 field study sponsored by EPA Region 7. Results of this field evaluation are published in an EPA report titled "A Field-Based Intercomparison of the Qualitative and Quantitative Performance of Multiple Open-Path FTIR Systems for Measurement of Selected Toxic Air Pollutants."

Another field evaluation of the AirSentry FTIR spectrometer was conducted at a Superfund site in January 1992. During the field evaluation, the FTIR spectrometer was compared with gas chromatography/mass spectrometry techniques using air samples collected in canisters. Results from this field evaluation are published in an EPA report titled "Superfund Innovative Technology Evaluation, The Delaware SITE Study, 1992" (EPA/600/A3-91/071).

Using other funding sources, EPA has continued research in this area and has released a guidance document applicable to all FTIR-based open path monitoring systems. The document is available from EPA (EPA/600/R-96/040). A guidance document detailing the steps required for successful field operation of the FTIR-based open path monitoring system is available from EPA in draft form. For a copy of the draft document, contact the EPA Project Manager listed below. The final version of the document will be added to the "EPA Compendium of Methods for Determination of Toxic Organic Compounds in the Ambient Air" as method TO-16.

This technology is no longer available from the developer. For further information about the technology, contact the EPA Project Manager.

FOR FURTHER INFORMATION:

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FUGRO GEOSCIENCES, INC.
(formerly LORAL CORPORATION)
(Rapid Optical Screening Tool)

TECHNOLOGY DESCRIPTION:

The Fugro Geoscience, Inc., (Fugro) Rapid Optical Screening Tool (ROST) is a tunable dye laser system used with a cone penetrometer. The technology provides subsurface information such as detection of aromatic hydrocarbon contaminants in soils.

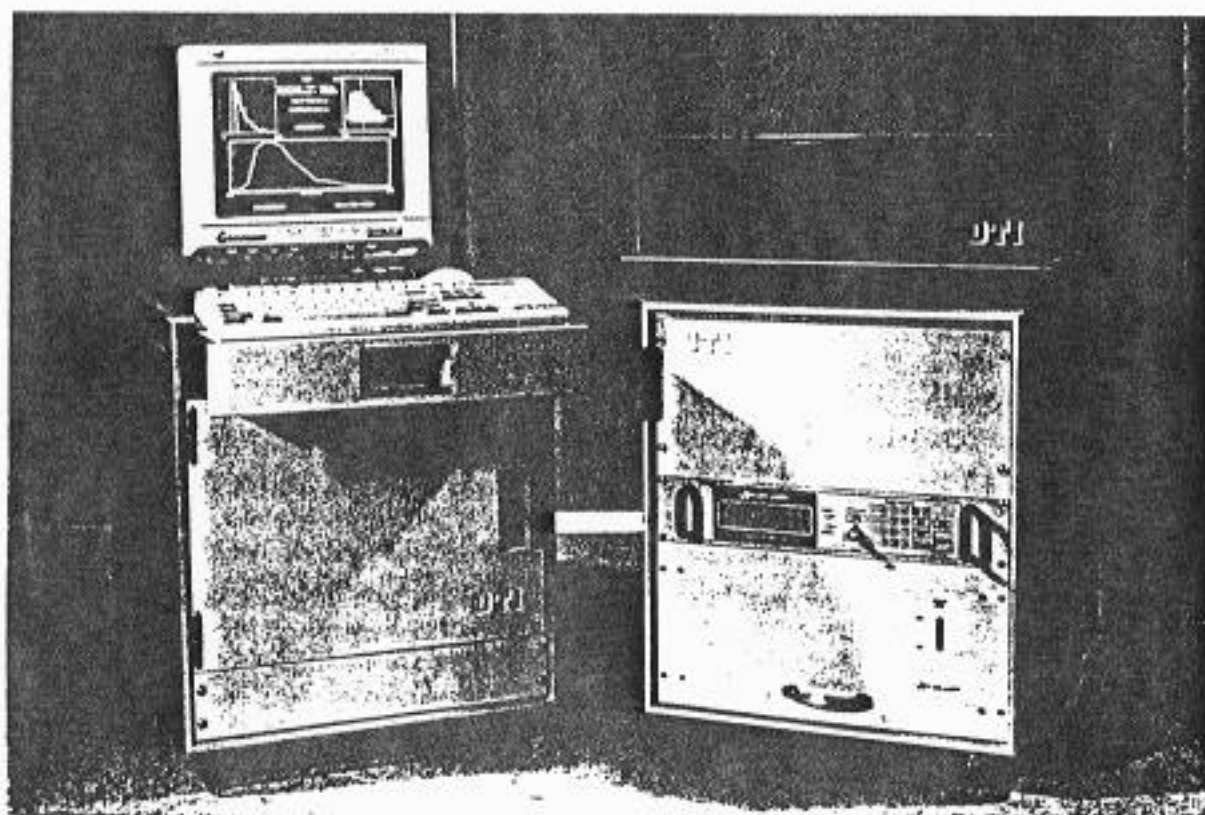
The ROST consists of a cone penetrometer (CPT) probe connected to a laser-induced fluorescence (LIF) sensor. A complete system consists of a truck, hydraulic rams and controllers, and the probe itself. The weight of the truck provides a static reaction force, typically 25 tons, to advance the CPT probe. The CPT probe, which is mounted on the end of the series of push rods, contains sensors that continuously log tip pressure and sleeve friction. The data from these sensors are used to map subsurface stratigraphy.

Conductivity or pore pressure sensors can be pushed into the ground.

The ROST system can be deployed with any conventional CPT system and advanced along with other types of sensors. The CPT probe contains a sapphire window that is mounted flush with the outside of the stainless- steel probe above the cone penetrometer tip. Light from an excitation laser passes through the sapphire window and is directed onto the soil as the CPT probe is advanced. The aromatic contaminants in the soil are fluoresced, and fiber optics return this information to the surface.

The main ROST system components are as follows:

- Neodymium-doped yttrium aluminum garnet (Nd:YAG) primary laser



Rapid Optical Screening Tool

- Tunable dye laser pumped by the Nd:YAG laser
- Fiber optic cable
- Monochromator to resolve the return fluorescence as a function of wavelength
- Photomultiplier tube (PMT) to convert photons into electrical signals
- Digital storage oscilloscope to capture waveforms from the PMT
- Control/analysis computer and software

The ROST system can be operated in both dynamic (push) and static modes. In the dynamic mode, the CPT probe equipped with the LIF sensor is advanced into the soil. In this mode, which Fugro refers to as fluorescence versus depth, the excitation laser wavelength and fluorescence emission monitoring wavelength are held constant. The fluorescence emission intensity is plotted as a function of depth below ground surface. The excitation wavelength is tunable across a range of wavelengths (266 nanometers [nm] to 310 nm) in order to capture contaminants such as benzene, toluene, ethylbenzene, xylene, naphthalene, and heavier polynuclear aromatic hydrocarbons (PAH). The emission monochromator is set at a wavelength to capture the peak intensity of the contaminants being investigated.

Once areas of significant contamination have been identified in the dynamic mode, the ROST system can be operated in the static mode to identify fuel types. In this mode, the CPT probe is held at a fixed depth. The fluorescence technician, who is observing the fluorescence signal, can signal the hydraulic operator to halt the push so that this "fingerprinting" information can be obtained. The ROST system also can operate in the static mode when additional push rods are added to the string.

WASTE APPLICABILITY:

The Fugro ROST system is designed to qualitatively and semi-quantitatively identify classes of petroleum, PAH, and volatile organic compound contamination in subsurface soil samples.

STATUS:

The ROST system was demonstrated in EPA Region 7, at sites in Iowa, Kansas, and Nebraska. The sampling and field analysis was conducted during September 1994. The Innovative Technology Evaluation Report (EPA/540/R-95/519) is available from EPA.

ROST's performance was verified by the Consortium for Site Characterization Technology (CSCT) at sites in California and New Mexico. CSCT is a partnership program involving EPA, the Department of Defense, and the Department of Energy. The CSCT field evaluations were conducted in May and November 1995 and the final report from the evaluation is available from EPA or Fugro.

Since the SITE and CSCT evaluations, multi-wavelength monitoring and continuous product differentiation features have been added to the system. These features are designed to further enhance ROST's detection and source identification capabilities.

FOR FURTHER INFORMATION:

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GEOPROBE SYSTEMS (Geoprobe Soil Conductivity Sensor)

TECHNOLOGY DESCRIPTION:

The Geoprobe soil conductivity sensor, shown in the figure below, identifies lithology and potential contamination by measuring the electrical conductivity of soil and hydrogeologic fluids. Soils vary in their electrical conductivity depending on particle size; for example, clays and silts generally have high conductivities, while sand and gravels exhibit low conductivities. Overall, soil and rock are resistant to current. Pore fluids and the amount of dissolved solids in these fluids also influence soil conductivity.

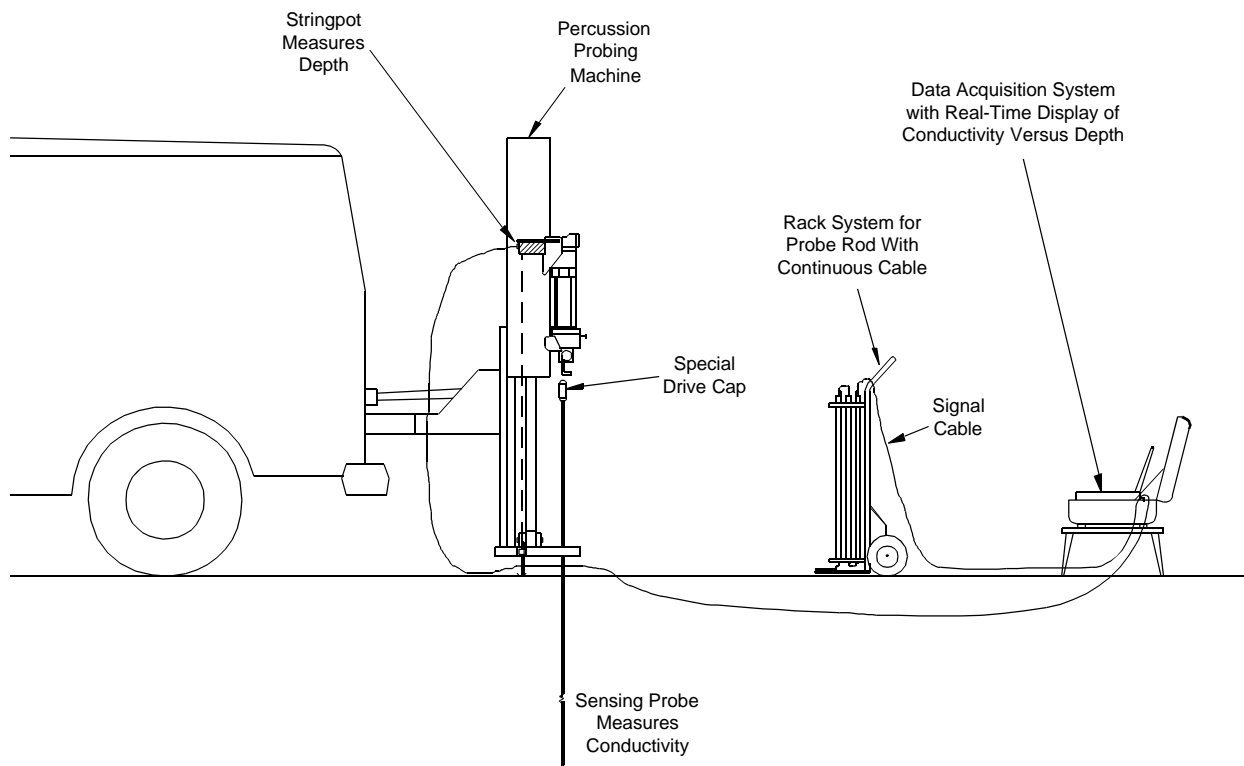
The Geoprobe conductivity sensor uses an isolated array of sensing rings to measure this conductivity. The sensor is principally designed to help determine subsurface stratigraphy. The sensor may also help characterize subsurface contamination, especially

where high conductivity leachates or brines are involved.

The principal components of the complete Geoprobe system are as follows:

- A Geoprobe hydraulic soil probing machine
- Standard sampling rods supplied with the system
- A cable, threaded through the sampling rod that introduces the current
- The conductivity sensor
- A data receiver connected to a personal computer to record the sensor's measurements

The hydraulic probing machine uses a combination of pushing and hammering to advance 3-foot-long segments of 2.54-centimeter-diameter hollow steel



Schematic Diagram of the Geoprobe Soil Conductivity Sensor

sampling rods. The conductivity sensor is attached to the lead section of the sampling rod.

The conductivity sensor consists of four stainless-steel contact rings fitted around a central steel shaft. Plastic electronically isolates the contact rings from the steel shaft. A hollow steel rod extends above the uppermost stainless steel ring, housing a shielded signal cable that connects the contact rings with an external power source, measurement system, and data logging system.

The soil conductivity sensor can be used in a dipole array or a Schlumberger array. The dipole array is used when greater resolution is required. The Schlumberger array is generally used when optimal soil-to-probe contact cannot be maintained.

WASTE APPLICABILITY:

The Geoprobe conductivity sensor is designed to determine subsurface stratigraphy. Only highly conductive contaminants such as oil field brine can be directly measured by the sensor.

STATUS:

The Geoprobe conductivity sensor field demonstration was conducted in September 1994. The final report will be available in 1997.

FOR FURTHER INFORMATION:

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GRASEBY IONICS, LTD., and PCP, INC.
(Ion Mobility Spectrometry)

TECHNOLOGY DESCRIPTION:

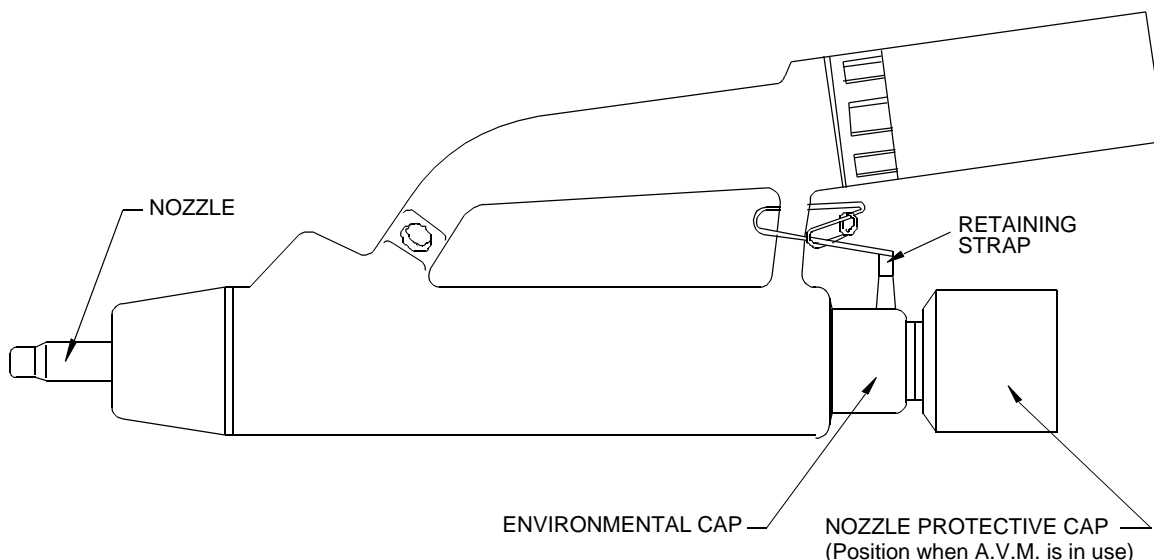
Ion mobility spectrometry (IMS) is a technique used to detect and characterize organic vapors in air. IMS involves the ionization of molecules and their subsequent temporal drift through an electric field. Analysis and characterization are based on analyte separations resulting from ionic mobilities rather than ionic masses; this difference distinguishes IMS from mass spectrometry. IMS operates at atmospheric pressure, a characteristic that has practical advantages over mass spectrometry, allowing a smaller analytical unit, lower power requirements, lighter weight, and easier use. These factors may facilitate use of IMS for mobile, field applications.

WASTE APPLICABILITY:

The IMS units, which are intended to be used in a preprogrammed fashion, can monitor chloroform, ethylbenzene, and other volatile organic compounds in a defined situation. IMS units can analyze air, vapor, soil, and water samples. However, for analysis of liquid and solid materials, the contaminants must be introduced to the instrument in the gas phase, requiring some sample preparation.

STATUS:

Graseby Ionics, Ltd. (Graseby), and PCP, Inc. (PCP), participated in a laboratory demonstration in 1990. Graseby used a commercially available,



Airborne Vapor Monitor for IMS

self-contained instrument that weighs about 2 kilograms (kg) (see figure on previous page). PCP used a larger (12 kg) transportable IMS. This laboratory demonstration was the first opportunity to test the instruments on environmental samples. The demonstration results highlighted that the following needs must be satisfied before IMS is ready for field applications:

- Additional development of sampling or sample preparation strategies for soil and water analysis
- Improvements in the design and performance of IMS inlets, in conjunction with the development of sampling and presentation procedures

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**HANBY ENVIRONMENTAL
LABORATORY PROCEDURES, INC.**
(Test Kits for Organic Contaminants in Soil and Water)

TECHNOLOGY DESCRIPTION:

Hanby Environmental Laboratory Procedures, Inc. (H.E.L.P.), field test kits for soil and water provide rapid, sensitive analyses for a broad range of organic contaminants. The kits have been used at spill and leak sites for petroleum substances including fuels, solvents, oils, pesticides, herbicides, and indirectly wood preservatives such as pentachlorophenols (PCP). The test kit methods are based on simple extraction and colorimetric procedures using Friedel-Crafts (F-C) chemical reactions. During analyses for PCPs suspended in diesel fuel carrier solvent, where the actual analyte does not undergo F-C reactions, it is necessary to perform other analyses to determine the ratio of the target compound to the detected carrier solvent. At locations where the type of contaminant is

known, such as gasoline or diesel fuel sites, the appropriate calibration photograph for the substance is used which provides precise quantitative analytical information. Alternatively, H.E.L.P. provides a portable spectrophotometer which reads the sample results, identifying a wider variety of chemicals.

The test kits provide the equipment and reagents to perform 15 soil or water samples. Soil tests are performed using the following steps:

- Using the electronic balance, weigh 5 grams of soil into a beaker.
- Empty one solvent ampule into the beaker.
- Stir the sample for 2 minutes (extraction).
- Pour extract from the beaker into one of the sample test tubes.
- Empty one catalyst powder vial into the test



Hanby Test Kit

tube, cap and shake for 3 minutes.

- Compare the developed color of the sample to the appropriate calibration photograph, or insert the test tube into the spectrophotometer for readout.

Water testing is performed in a similar manner, except that the extraction procedure is performed on a 500-milliliter water sample in a separatory funnel which comes with the water test kit.

WASTE APPLICABILITY:

H.E.L.P. field test kits analyze aromatic, halogenated, and other compounds which participate in F-C reactions. These compounds include the complete range of fuel types such as gasoline, diesel fuel, and jet fuel, as well as all types of crude oils. The test kits are also used for the measurement of many other types of substances such as new and used motor oils, transformer oils, hydraulic fluids, and other types of organic liquids which contain only small amounts of F-C reacting compounds. The intense color of these reactions allows sensitivities of detection from 1 to 25 parts per million (ppm).

The availability of two solvent types for the kits provides a range from 1 ppm (with the lower range solvent) to 100,00 ppm (with the high range solvent).

STATUS:

The H.E.L.P. test kit was used to indirectly screen and quantify PCP contamination in soils for a SITE demonstration in Morrisville, North Carolina in August 1993, using samples collected from a wood preserving site in Winona, Missouri. These samples contained PCP in a diesel carrier solvent. When the ratio of carrier solvent to PCP was constant, the PCP concentration data obtained using the H.E.L.P. test kit correlated well with sample splits analyzed at an off-site laboratory. Results from the demonstration have been published in an Innovative Technology Evaluation Report (EPA/540/R-95/514), which is available from EPA.

The field test kits and the associated spectrophotometer, the H.E.L.P. MATE 2000, were

selected by the U.S. Department of Commerce and EPA Rapid Commercialization Initiative (RCI) as representative of "best available demonstrated technology" in March 1996. The technologies selected for RCI will be demonstrated and assessed by EPA, the U.S. Departments of Energy, Commerce, and Defense, the California EPA, the Western Governor's Association, and the Southern States Energy Board throughout 1996 and 1997.

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HNU SYSTEMS, INC.
**(HNU Source Excited Fluorescence
Analyzer-Portable [SEFA-P] X-Ray Fluorescence Analyzer)**

TECHNOLOGY DESCRIPTION:

HNU developed the SEFA-P, a portable X-ray technology, to selectively determine metals concentrations in soils and other media at hazardous waste sites or industrial locations. Three excitation sources are offered with the SEFA-P X-ray fluorescence (XRF) Analyzer: Iron-55, Cadmium-109, and Americium-241.

The SEFA-P in its most basic form consists of the following components: one main cabinet that encloses the sample chamber; the excitation sources; a liquid nitrogen-cooled Si(Li) detector; a preamplifier; spectrometer electronics; an MCA; and a battery charger. The internal battery can power the MCA for 8 hours. The MCA has an RS232 interface that allows the SEFA-P to be externally controlled through a PC



Source Excited Fluorescence Analyzer-Portable (SEFA-P) XRF Analyzer

or laptop computer. The SEFA-P weighs approximately 50 pounds.

The SEFA-P can be calibrated empirically or using the Compton ratio. Quantitative results for samples are displayed on the PC screen in units of parts per million. The SEFA-P only analyzes soil samples in the intrusive mode; soil samples are placed in sample cups prior to analysis. After calibrating the unit, analyzing quality control samples, and preparing samples, it is possible to analyze 30 to 50 samples in an 8- to 10-hour day.

The SEFA-P is sold with a general license, so the operator does not have to be specifically licensed in each state in which it is used. As of 1995, the SEFA-P retailed for approximately \$45,000 depending on the options included. This price includes one in-house operational training course.

WASTE APPLICABILITY:

The SEFA-P can detect elements from aluminum through uranium in soil or other media, such as those elements at mining and smelting sites, drum recycling facilities, or plating facilities. The instrument can provide real-time, on-site analytical results during field screening and remedial operations. XRF analysis is faster and more cost-effective compared to conventional laboratory analysis.

STATUS:

The SEFA-P has been used at a number of Superfund sites across the country. A SITE demonstration of the SEFA-P was conducted in February 1995. The instrument was used to identify and quantify concentrations of metals in soils. A preliminary evaluation of the results yielded field-based method detection limits, accuracy, and precision data from the analysis of standard reference materials and performance evaluation samples. Comparability of the XRF results to an EPA-approved reference laboratory method was also assessed. An SW-846 method for XRF analysis of soils is scheduled to be published in 1997. A comprehensive evaluation of all results will be presented in a technical report from EPA in 1997.

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HNU SYSTEMS, INC.
(HNU GC 311D Portable Gas Chromatograph)

TECHNOLOGY DESCRIPTION:

The field-deployable HNU GC 311D portable gas chromatograph monitors a wide range of compound emissions from hazardous waste sites and other emissions sources before and during remediation (see figure below). It has an internal carrier gas supply, operates on 110-volt line power, is microprocessor-controlled, and is temperature programmable. An internal printer plots chromatograms and prints data. Data can also be reported to an external computer, which is connected through an RS-232 outlet.

The instrument has simultaneous dual-detector capability and allows the user to choose from four

interchangeable detectors: photoionization, flame ionization, electron-capture, and far ultraviolet absorbance. Capillary columns of all sizes can be installed. The instrument is capable of autosampling.

WASTE APPLICABILITY:

The HNU GC 311D is applicable to a wide variety of vapor-phase pollutants. The photoionization detector is sensitive to compounds that ionize below 11.7 electron volts, such as aromatic compounds and unsaturated halocarbons. The flame ionization detector is sensitive to hydrocarbons. The electron-capture detector is sensitive to halocarbons and polychlorinated biphenyls. The far ultraviolet



HNU GC 311D Portable Gas Chromatograph

absorbance is a universal detector with characteristics similar to that of a TCD.

STATUS:

The instrument was evaluated in January 1992 at a Superfund site under remediation. Results from the demonstration are presented in a peer-reviewed article entitled "Evaluation of Portable Gas Chromatographs" in the *Proceedings of the 1993 U.S. EPA/Air and Waste Management Association International Symposium*, VIP-33, Volume 2, 1993. A final report will not be prepared.

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IDETEK, INC.
(formerly BINAX CORPORATION, ANTOX DIVISION)
(Equate® Immunoassay)

TECHNOLOGY DESCRIPTION:

The Equate® immunoassay (see photograph below) uses an anti-benzene, toluene, and xylene (BTX) polyclonal antibody to facilitate analysis of BTX in water. A hapten-enzyme conjugate mimics free BTX hydrocarbons and competes for binding to the polyclonal antibody immobilized on a test tube. After the test tube is washed to remove unbound conjugate, a substrate chromogen mixture is added and a colored enzymatic reaction product forms. The enzymatic reaction is stopped by adding a few drops of sulfuric acid, which colors the enzymatic product yellow.

As with other competitive enzyme-linked immunosorbent assays, the color intensity of the

enzymatic product is inversely proportional to the sample analyte concentration. Each sample is run with a reference sample of deionized water. The optical density of the colored enzymatic product is read on a portable digital colorimeter equipped with a filter that passes light at a peak wavelength of 450 nanometers. The ratio of the sample to the reference optical density values is used to estimate the aromatic hydrocarbon level in the low parts per million (ppm) range. The test is sensitive to about 1 ppm and requires 5 to 10 minutes per analysis.

WASTE APPLICABILITY:

The Equate® immunoassay is designed to measure BTX in water.



Equate® Immunoassay Kit

STATUS:

The National Exposure Research Laboratory-Las Vegas evaluated several versions of the Equate® immunoassay. The evaluation focused on cross-reactivity and interference testing and on analysis of benzene, toluene, ethylbenzene, and xylene and gasoline standard curves.

As a preliminary field evaluation, the Equate® immunoassay was used to analyze in duplicate five well samples and a creek sample, both in the field and the laboratory. Confirmatory analysis was conducted using purge-and-trap gas chromatography with an electron-capture detector, in parallel with a photoionization detector.

A SITE demonstration of the Equate® immunoassay was conducted in 1992. Results from this demonstration were published in June 1994 in an EPA report entitled "Superfund Innovative Technology Evaluation (SITE) Program Evaluation Report for Antox BTX Water Screen (BTX Immunoassay)" (EPA/540/R-93/518).

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METOREX, INC.
(Field Portable X-Ray Fluorescence Analyzers)

TECHNOLOGY DESCRIPTION:

Metorex, Inc. (Metorex), manufactures, sells, rents, leases, and provides analytical and repair services for its X-MET line of field portable X-ray fluorescence (FPXRF) analyzers. The latest X-MET models in this series of instruments are the 920 and 940 X-MET systems. The X-MET 920 series includes the X-MET 920-P and 920-MP. The X-MET analyzers are specifically calibrated for on-site or in situ hazardous waste analysis. These analyzers provide rapid, nondestructive measurements of inorganic contaminants in soil, thin film such as lead in paint, or water matrices.

Each X-MET 920 series analyzer is built from modules into systems based on customers' analytical and logistical needs. X-MET PC System (XPCS) can either be built into the expansion slot of the computer or is provided as a standalone, battery-operated XPCS module for direct interface to a computer's RS-232 port. The X-MET 940 is a custom, miniaturized, field-hardened, battery-operated, DOS-based computer which is dedicated to field XRF application. The system uses a flash or electronic hard disk to provide extreme durability under field operating conditions. It is among the smallest, lightest commercially available FPXRF with the full range of analytical capabilities.

The X-MET 920-P is equipped with a solid state Si(Li) contained in a hand-held probe. The X-MET 920 MP is equipped with a gas-filled proportional counter detector contained in a hand-held probe. The basic analyzer configuration includes the PC, XRF software, XPCS, and the analysis probe with excitation source. The XPCS contains a 2,048-channel multichannel analyzer (MCA) that collects, analyzes, and displays the X-ray pulse-height spectrum. The high-resolution Si(Li) detector is liquid nitrogen cooled by a 0.5-liter dewar built into the probe. The gas-filled proportional detector operates at ambient temperatures. Metorex offers iron⁵⁵, cadmium¹⁰⁹, and americium ²⁴¹ radioisotope excitation sources. Dual source configurations are available.

All software is menu driven. These instruments are factory-calibrated and can be field-calibrated using either empirical calibration or standardless-fundamental parameters (FP). Empirical calibration requires a set of site-typical or analyzed site-specific samples for the initial calibration. FP calibration requires one certified standard. Metorex claims that 50 or more soil samples can be analyzed in an 8- to 10-hour day with intrusive sampling, rigorous sample preparation, and long measurement times (200 to 300 seconds per sample) and up to 200 samples per day with in situ screening and short (10 to 100 seconds per sample) measurement times.

The X-MET 920-P, equipped with a Si(Li) detector, dual radioisotope sources, and a portable sealed computer, sells for \$47,950. The X-MET 920 MP sells for \$36,325 and the X-MET 940 sells for \$62,430. These prices include factory training for two people at the Metorex facility. The X-MET can also be rented or leased from Metorex.

WASTE APPLICABILITY:

The X-MET technology is designed to identify more than 60 elements in soil or other matrices, such as those at mining and smelting sites, drum recycling facilities, or plating facilities. The instrument can provide real-time, on-site analytical results during field screening and remediation operations. FPXRF analysis is faster and more cost-effective compared to conventional laboratory analysis.

STATUS:

The X-MET 920-P, 920-MP, and 940 were evaluated under the SITE Program in April 1995. The instruments were used to identify and quantify concentrations of metals in soils. A preliminary evaluation of the results yielded field-based method detection limits, accuracy, and precision data from the analysis of standard reference materials and performance evaluation samples. Comparability of the FPXRF results to an EPA-approved reference laboratory method was also assessed. A SW-846 method for FPXRF analysis of soils is scheduled to be published in 1996. The results from the evaluation of the X-MET 920-P and 940 analyzers were combined in a single report. Results from the evaluation of the X-MET 920-MP analyzer were reported in a separate report. A comprehensive evaluation of all results will be presented in a technical report from EPA in 1997.

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MICROSENSOR SYSTEMS, INCORPORATED **(MSI-301A Vapor Monitor)**

TECHNOLOGY DESCRIPTION:

The MSI-301A vapor monitor is a portable, temperature-controlled gas chromatograph with a highly selective surface acoustic wave detector and an on-board computer (see photograph below). The MSI-301A vapor monitor performs the following functions:

- Preconcentrates samples and uses scrubbed ambient air as a carrier gas
- Analyzes a limited group of preselected compounds, such as benzene, toluene, and xylenes, at part per billion levels
- Operates by battery and includes an RS-232 interface
- Operates automatically as a stationary sampler or manually as a mobile unit

WASTE APPLICABILITY:

The MSI-301A vapor monitor can monitor many volatile organic compound emissions from hazardous waste sites and other sources before and during remediation.

STATUS:

In January 1992, the MSI-301A vapor monitor was evaluated in the field at a Superfund site. Results from the demonstration are presented in a peer-reviewed article entitled "Evaluation of Portable Gas Chromatographs" in the *Proceedings of the 1993 U.S. EPA/Air and Waste Management Association International Symposium*, VIP-33, Volume 2, 1993.



MSI-301A Vapor Monitor

FOR FURTHER INFORMATION:

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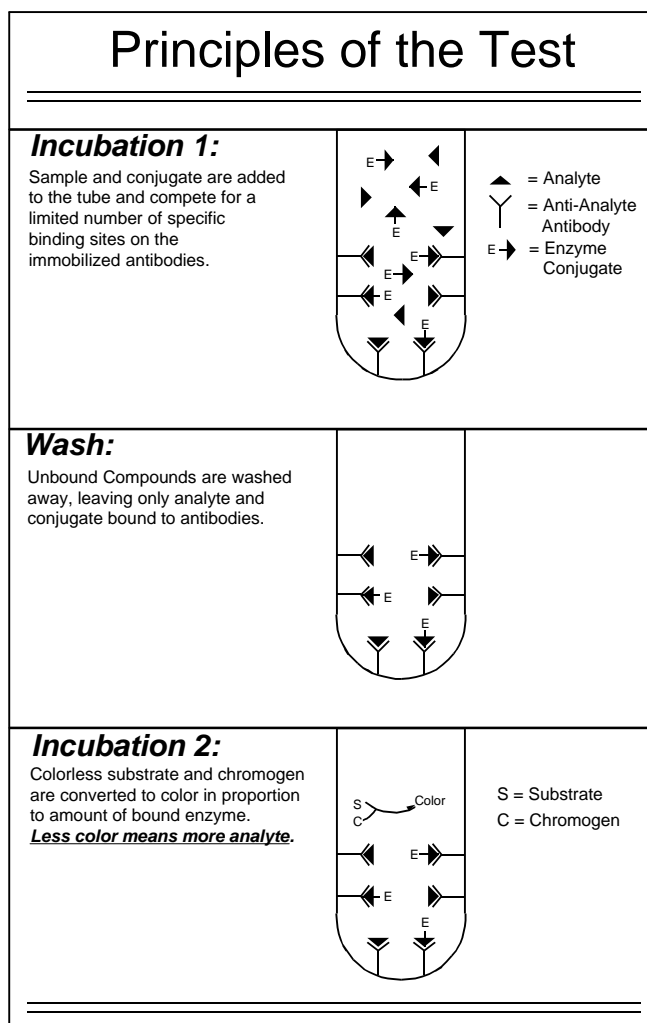
MILLIPORE CORPORATION
(EnviroGard™ PCB Immunoassay Test Kit)

TECHNOLOGY DESCRIPTION:

The EnviroGard™ polychlorinated biphenyl (PCB) immunoassay test kit rapidly analyzes for PCB concentrations in samples of soil or sediment. The operating procedure for this competitive enzyme-linked immunoassay kit is shown in the figure below.

Soil sample extracts are prepared using the EnviroGard™ Soil Extraction Kit and methanol. These extracts and assay calibration solutions are

added to plastic test tubes coated with antibodies. PCB-enzyme conjugate is added to each test tube. The test tubes then stand for 15 minutes. The antibodies in each test tube bind with either PCB molecules or enzyme conjugate. Next, the tubes are washed to remove any material not bound to the antibodies. A clear substrate/chromogen solution is then added to each tube, and the tubes are allowed to stand for 5 minutes. Any enzyme conjugate bound to the tubes colors the clear substrate blue. A deeper shade of blue in the test tube indicates a lower PCB concentration.



Test Kit Procedure

The color intensity in the test tubes is measured at 450 nanometers using a small portable photometer. The color intensity is compared to one or more of the four calibrator solutions included in the kit to yield data allowing classification above or below 1, 5, 10, or 50 parts per million (ppm). Up to 18 sample extracts can be analyzed in less than 30 minutes. Millipore Corporation (Millipore) can provide optional protocols for quantitative analysis of specific Aroclors or for testing sediment, water, or soil samples.

WASTE APPLICABILITY:

The EnviroGard™ PCB test kit measures PCB concentrations in soil or sediment. The test is calibrated to screen for Aroclors 1016, 1232, 1242, 1248, 1254, and 1260 at greater than 95 percent confidence interval.

STATUS:

In 1991, the EnviroGard™ PCB test kit was used to screen and quantify PCB contamination in soils at a SITE demonstration of a solvent extraction system in Washburn, Maine.

Soil containing over 50 ppm PCB was required for the demonstration at the Washburn, Maine site. Calibrators at the 5 and 50 ppm level were used to evaluate the kit's potential for segregating soils. Additional tests were performed on dilutions of the soil extracts to evaluate quantitative performance. Highly contaminated soils were easily identified, and quantitative tests provided correlation to contaminant levels obtained by off-site laboratory analysis using EPA Method 8080. The Innovative Technology Evaluation Report (EPA/540/R-95/517) is available from EPA.

The kit was also demonstrated at a U.S. Department of Energy (DOE) site in Kansas City, Missouri. Soils contaminated with Aroclor 1242 in ranges from nondetectable to greater than 1,000 ppm were analyzed with the test kit at the DOE facility. Over 200 assays of environmental samples and calibrators were performed to evaluate correlation with both on-site and off-site laboratory gas chromatograph data. Final evaluation of the data will be presented in the Technology Evaluation Report.

The EnviroGard™ PCB test kit has been accepted by the EPA Office of Solid Waste for inclusion in SW-846 as Method 4020.

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MILLIPORE CORPORATION
(EnviroGard™ PCP Immunoassay Test Kit)

TECHNOLOGY DESCRIPTION:

The EnviroGard™ pentachlorophenol (PCP) immunoassay test kit, shown in the photograph below, rapidly analyzes soil and water samples at sites contaminated with PCP. The procedure is performed by adding a water or soil sample extract to test tubes coated with a specific antibody along with a PCP-enzyme conjugate. The PCP from the sample and the enzyme conjugate compete for immobilized anti-PCP antibody binding sites. After the initial competitive reaction, any unbound enzyme conjugate is washed from the tubes and a clear substrate is added. Any bound enzyme conjugate colors the clear substrate blue. A small portable photometer is used to measure the color intensity, which is inversely related to the concentration of

the PCP in the original sample or calibrator solution.

The amount of color in the sample tubes is compared to calibrators corresponding to either 10 and 100 parts per million (ppm) for soil samples or 5 and 50 parts per billion (ppb) for water samples. Different detection levels can be achieved by diluting either the soil sample extract or the water sample.

The test kit has been tested for interferences with humic acids, pH, water content in soil samples, and oil co-contamination. Humic acid content in sample extracts greater than 10,000 ppb may cause false positive results. Samples with pH within the range of 4 to 14 were found to be correctly evaluated. The test kit correctly



EnviroGard™ PCP Immunoassay Test Kit

evaluated soils containing water up to 30 percent by weight, as well as samples containing water up to 10 percent by weight. Soil samples containing up to 10 percent oil were also correctly evaluated by the test kit.

WASTE APPLICABILITY:

The EnviroGard™ PCP test kit measures PCP in water samples and extracts of soil samples. Detection limits are 10 ppm for soil samples and 5 ppb for water samples.

STATUS:

The EnviroGard™ PCP test kit was used to screen and quantify PCP contamination in soil and groundwater during a SITE demonstration in Morrisville, North Carolina in August 1993. The PCP carrier used at this site was a mixture of isopropyl ether and butane. In addition, soil and groundwater samples collected from a wood-preserving site in Winona, Missouri were tested during the demonstration. Diesel fuel was used as the PCP carrier at this site.

The test kit did not meet acceptable accuracy requirements during the demonstration. Millipore has since developed a revised protocol for PCP analysis. Millipore believes the revised protocol improves the accuracy and reproducibility of the test.

The Innovative Technology Evaluation Report (EPA/540/R-95/514), which details results from the demonstration, is available from EPA.

The EnviroGard™ PCP test kit has been accepted by the EPA Office of Solid Waste for inclusion in SW-846 as Method 4010A.

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MTI ANALYTICAL INSTRUMENTS
(formerly **MICROSENSOR TECHNOLOGY, INCORPORATED**)
(Portable Gas Analyzer)

TECHNOLOGY DESCRIPTION:

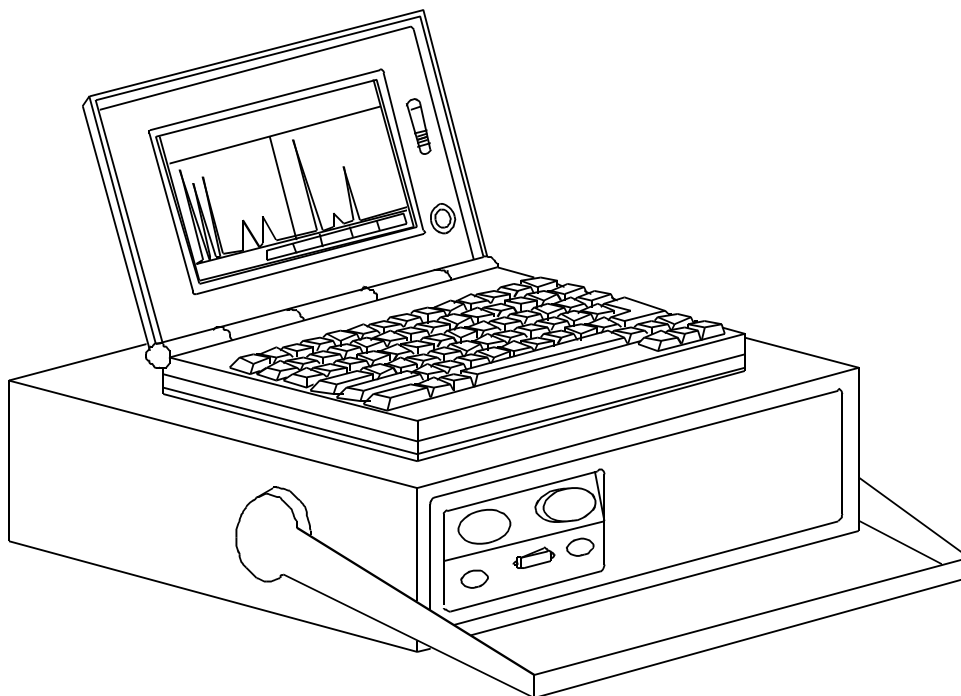
The MTI Analytical Instruments (MTI) P200 gas analyzer, shown below, is a dual-channel, high-speed, portable micro gas chromatograph (GC) that provides isothermal analysis of gas-phase samples. The injector and thermal conductivity detector (TCD) are micromachined in silicon, generating high-quality, high-precision chromatographic components. The dimensions of these silicon devices enable the use of microbore capillary columns with an inner diameter of 0.320 millimeter or less.

Gas-phase samples are drawn into a sample loop with an internal vacuum pump. An aliquot of the sample is then introduced onto the capillary column

using the microvalves of the silicon injector. All analyses are completed in less than 160 seconds, making the P200 gas analyzer one of the fastest commercially available GCs.

The P200 gas analyzer houses an internal sealed lead acid battery and an internal supply cylinder of carrier gas providing 6 to 8 hours of continuous operation. When interfaced with a laptop computer and used with MTI's chromatography data system, the P200 is fully capable of field operation.

The P200 gas analyzer has a minimum detectable level of 1 part per million for a wide variety of volatile organic compounds (VOC), including xylenes. A heated sample inlet system enables the P200 gas analyzer to detect naphthalene and



P200 Gas Analyzer

hexachlorobutadiene. MTI's Trapper 2000 portable sample concentrator extends the analytical detection limit of the P200 to about 1 to 10 parts per billion for EPA Method TO-14 compounds.

WASTE APPLICABILITY:

The P200 gas analyzer is capable of analyzing soil gases, VOC contaminants in groundwater, and, with the use of the Trapper 2000 portable sample concentrator, VOCs in ambient air (for example, Method TO-14 compounds). The micro TCD is suitable for analyzing many types of organic and inorganic vapor-phase compounds. The P200 gas analyzer can be used to monitor VOC emissions from hazardous waste sites before and during remediation. Because of its portability, high analytical speed, and relatively low detection limit, this field GC provides not only rapid field screening of VOCs, but also provides results of similar quality to those produced by a laboratory GC mass spectrometer.

STATUS:

The P200 gas analyzer was evaluated during a field study in August 1995. During the study, downwind vapors from an artificial source generator were analyzed. Preliminary results of the demonstration were presented in an article titled "Performance Comparison of Field-Deployable Gas Chromatographs with Canister TO-14 Analyses" in the *Proceeding of the 1996 U.S. EPA/Air and Waste Management Association International Symposium*, VIP-64, 1996.

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NAVAL COMMAND, CONTROL, AND OCEAN SURVEILLANCE CENTER (SCAPS Cone Penetrometer)

TECHNOLOGY DESCRIPTION:

The Site Characterization and Analysis Penetrometer System (SCAPS) was developed by the Naval Command, Control and Ocean Surveillance Center, Research, Development, Test, and Evaluation Division. SCAPS is mounted on a cone penetrometer testing (CPT) platform for field use; it can be fitted with a laser-induced fluorescence (LIF) sensor to provide in situ field screening of petroleum hydrocarbons in subsurface soils. CPT technology has been widely used in the geotechnical industry for determining soil strength and soil type from measurements of tip resistance and sleeve friction on an instrumented probe. The SCAPS CPT platform equipped with LIF sensors can provide real-time field screening of the physical characteristics of soil and chemical characteristics of petroleum hydrocarbon contamination at hazardous waste sites.

SCAPS is primarily designed to quickly and cost-effectively distinguish hydrocarbon-contaminated areas from uncontaminated areas. SCAPS also provides geologic information and reduces the amount of investigation-derived waste. This capability allows further investigation and remediation decisions to be made more efficiently and reduces the number of samples that must be submitted for laboratory analysis.

The LIF system uses a pulsed laser coupled with an optical detector to measure fluorescence through optical fibers. Fluorescence is measured through a sapphire window on a probe that is pushed into the ground with a truck-mounted CPT. LIF provides data on the in situ distribution of petroleum hydrocarbons, measured by the fluorescence response induced in the polynuclear aromatic hydrocarbons (PAH) that comprise the petroleum hydrocarbon. LIF detects PAHs in the bulk soil matrix throughout the vadose, capillary fringe, and saturated zones. LIF also provides a detect-nondetect field screening capability relative to a specified detection limit derived for a specific fuel product on a site-specific soil matrix. In addition,

LIF provides qualitative data derived from spectrographic data at depths up to 150 feet.

WASTE APPLICABILITY:

SCAPS CPT technology equipped with LIF sensors can provide real-time qualitative analysis of subsurface soils. This technology may be useful in screening soils at oil refineries, tank farms, and shipyards. The combined technologies provide substantial cost savings and quicker analyses compared to conventional laboratories.

STATUS:

The SCAPS CPT and LIF technologies were demonstrated at two hydrogeologically distinct field sites under the SITE Characterization and Monitoring Program. The demonstrations were conducted at the Hydrocarbon National Test Site at the Naval Construction Battalion Center in Port Hueneme, California in May 1995, and the Steam Plant Tank Farm, Sandia National Laboratories in Albuquerque, New Mexico in November 1995. An Innovative Technology Evaluation Report (ITER) (EPA/540/R-95/520) was published by EPA.

The SCAPS project is meeting the Navy's goals of (1) expedited development and regulatory acceptance, (2) performance of urgently needed petroleum, oil, and lubricant (POL) field screening at Navy facilities, and (3) technology transfer to industry for widespread use. The SCAPS LIF technology is certified and verified. The technology has matured to become a platform with state-of-the-art sensor technology and a suite of the latest CPT tools for sampling and direct push well installations. On August 5, 1996, the California EPA Department of Toxic Substance Control certified the SCAPS LIF as a site characterization technology for real-time, in situ subsurface field screening for POL contaminants, pursuant to California Health and Safety Code, Section 25200.1.5.

Three SCAPS units are performing POL field screenings at Navy facilities on a prioritized basis.

These screenings include plume chasing and plume edge delineation on a finer scale than has been feasible in the past.

DEMONSTRATION RESULTS:

The results of the SCAPS demonstrations at Port Hueneme and Sandia National Laboratories were presented in the ITER and are summarized below:

- SCAPS met the demonstration objective of providing real-time screening of the physical characteristics of soil and chemical characteristics of petroleum hydrocarbon contamination.
- SCAPS achieved better than 90 percent agreement with the discrete soil samples and analytical results.
- SCAPS is capable of mapping the relative magnitude and the vertical and horizontal extent of subsurface fluorescent petroleum hydrocarbon contaminant plumes in soil and groundwater.

FOR FURTHER INFORMATION:

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NITON CORPORATION (XL Spectrum Analyzer)

TECHNOLOGY DESCRIPTION:

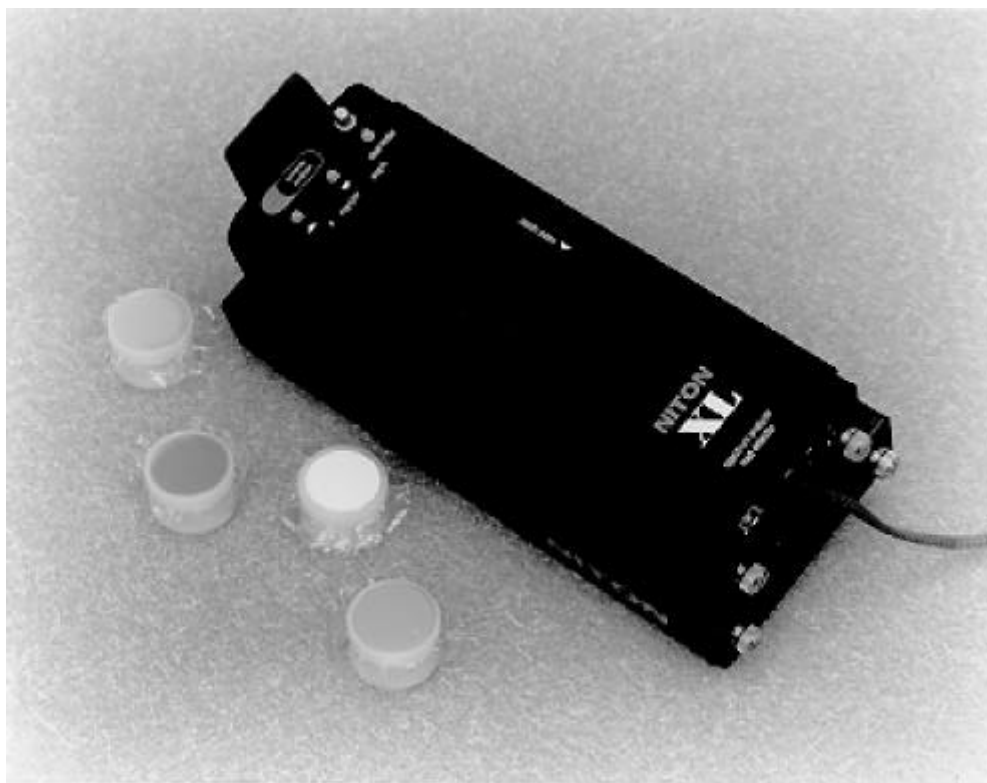
NITON Corporation (Niton) manufactures and services the XL Spectrum Analyzer, a hand-held, field portable X-ray fluorescence (FPXRF) instrument. The XL Spectrum Analyzer allows in situ and on-site measurement of select metals in paint films, soil, and other media. Niton originally designed the XL Spectrum Analyzer for fast, accurate, nondestructive measurement of lead in paint.

The XL Spectrum Analyzer includes a cadmium-109 radioactive source (10 millicurie) that provides the excitation energy which produces characteristic fluorescent X-rays from a sample. The instrument includes a silicon Pin-diode detector, cooled by the thermoelectric Peltier effect. The instrument also includes (1) a multichannel analyzer of 1,024 channels, (2) an RS-232 serial port for data

transfer and printing, (3) an internal memory for storing up to 500 readings with spectra, and (4) a back-lit graphic liquid crystal display.

The instrument self-calibrates its energy scale and uses a Compton backscatter calibration technique. This calibration compensates for X-ray absorption in the soil matrix. The instrument is equipped with a removable battery pack that provides up to 8 hours of continuous use. It can analyze 200 to 300 samples in an 8- to 10-hour day, based on a 60-second analysis time and minimal sample preparation. The complete instrument, shown in the photograph below, weighs less than 3 pounds.

Niton requires a 2-day operator training and radiation safety course, which is provided by Star Environmental Services at a cost of \$350 per person. Niton manufactures the XL Spectrum Analyzer under a specific license with the State of



XL Spectrum Analyzer

Rhode Island. In general, an operator must be state licensed to possess and operate the instrument.

The standard XL Spectrum Analyzer costs \$11,990, which includes the battery pack and charger, automotive power adapter, cable for serial data downloading, waterproof carrying case, operating and safety manual, paint film standards, barcode wand, personal computer software, and a 2-year warranty. The soil analysis application package costs an additional \$6,000 and includes application software, sample collection and preparation equipment, accessories for measuring soil in place or in sample cups, soil standards, a user's manual, and a plastic carrying case. An extra battery pack costs \$300. The cadmium-109 source, which has a half-life of 15 months, costs \$2,200 to replace.

WASTE APPLICABILITY:

The XL Spectrum Analyzer can detect more than 15 elements in soil samples, such as those obtained from lead-contaminated residences, mining and smelting sites, drum recycling facilities, and plating facilities. The instrument can provide real-time, on-site analytical results during field screening and remediation operations. FPXRF analysis is faster and more cost-effective compared to conventional laboratory analysis.

STATUS:

The XL Spectrum Analyzer was demonstrated under the SITE Program in April 1995. The instrument was used to identify and quantify concentrations of metals in soils. A preliminary evaluation of the results yielded field-based method detection limits, accuracy, and precision data from the analysis of standard reference materials and performance evaluation samples. Comparability of the FPXRF results to an EPA-approved reference laboratory method was also assessed. An SW-846 method for FPXRF analysis of soils was published in 1996. A comprehensive evaluation of all results will be presented in a technical report from EPA in 1997.

FOR FURTHER INFORMATION:

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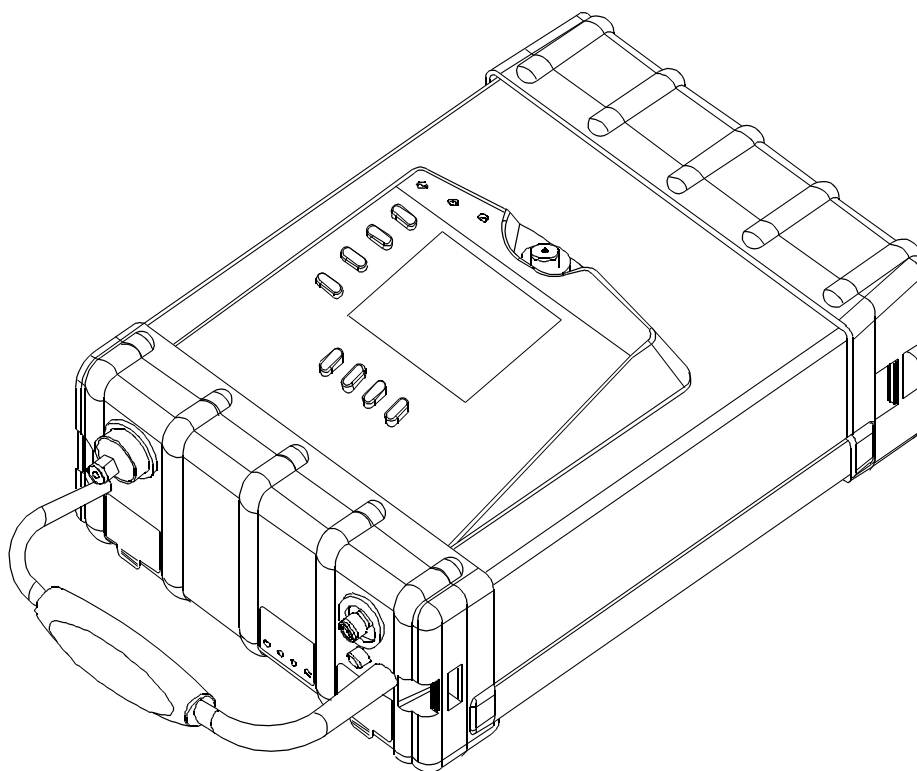
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PHOTOVAC MONITORING INSTRUMENTS
(formerly PHOTOVAC INTERNATIONAL, INC.)
(PE Photovac Voyager Portable Gas Chromatograph)

TECHNOLOGY DESCRIPTION:

The PE Photovac Voyager Portable Gas Chromatograph (GC) is a lightweight, battery powered, isothermal GC (see figure below). The Voyager GC is designed to replace the Photovac 10S Plus GC and incorporates the following design changes:

- A miniature analytical engine is comprised of a precolumn/backflush three-column set, with a dedicated column for “light,” “middle,” and “heavy” compounds; isothermal oven with an operating temperature up to 80°C; a miniature all-steel valve array; and a syringe/valve injection port. The whole engine is maintained at the set isothermal temperature.
- The 10.6-electron-volt (eV) photoionization detector (PID) matches the sensitivity of the 10S Plus GC for benzene, toluene, xylenes, and chlorinated ethylenes.
- The Voyager GC includes a variety of detectors, such as an electron-capture detector (ECD), to provide high sensitivity for the chlorinated alkanes.
- A total volatile organic compound (VOC) function (using the PID only) is intended primarily as a fast screening tool for pre-GC analysis; the VOC function supports either syringe or automatic (using the internal pump) injections.
- Factory-programmed assay for up to 40 VOCs listed in EPA Method 624.
- A “simplified” operating mode designed



PE-Photovac Voyager Portable Gas Chromatograph

to detect a subset of VOCs selected from the preprogrammed assay.

- An “advanced” operating mode allows extensive method customization, such as adding compounds to the preprogrammed assay.
- Total weight with PID is 15 pounds.

WASTE APPLICABILITY:

The Voyager GC can monitor VOC emissions from hazardous waste sites and other emission sources before, during, and after remediation. It is more flexible in analytical functionality and has an extended scope of compound separation compared to the 10S Plus GC for monitoring VOC at ambient background levels.

STATUS:

The Photovac 10S PLUS GC was evaluated in January 1992 at a Superfund site under remediation. Results from this demonstration are presented in a peer-reviewed article entitled "Evaluation of Portable Gas Chromatographs" in the *Proceedings of the 1993 U.S. EPA/Air and Waste Management Association International Symposium*, VIP-33, Volume 2, 1993.

The Voyager GC was evaluated during a field study in August 1995. During the study, downwind vapors from an artificial source generator were analyzed. Preliminary results of the demonstration were presented in an article titled “Performance Comparison of Field-Deployable Gas Chromatographs with Canister TO-14 Analyses” in the *Proceeding of the 1996 U.S. EPA/Air and Waste Management Association International Symposium*, VIP-64, 1996.

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SCITEC CORPORATION
(Metal Analysis Probe [MAP®] Portable Assayer)

TECHNOLOGY DESCRIPTION:

The SCITEC Corporation MAP® Portable Assayer (see photograph below) is a field portable X-ray fluorescence (FPXRF) analyzer. This FPXRF analyzer can simultaneously analyze for select metals. It is compact, lightweight, and does not require liquid nitrogen. A rechargeable battery allows the FPXRF analyzer to be used at remote sites where electricity is unavailable.

The MAP® Portable Assayer uses a silicon X-ray detector to provide elemental resolution. The unit demonstrated under the SITE Program used a Cadmium-109 radioisotope as the excitation source.

The MAP® Portable Assayer provides high sample throughput and is reportedly easy to operate. Analytical results obtained by this

instrument may be comparable to the results obtained by EPA-approved methods.

The instrument is composed of a control console connected to an ambient scanner with a cable. The basic MAP® system also includes a carry pack, rechargeable batteries, operator's manual, target metal standard, and a shipping case. The control console contains a 256-multichannel analyzer (MCA) with a storage capacity of 325 spectra and analyses. The control console weighs 7 pounds and the ambient scanner weighs about 2.5 pounds.

The MAP® Portable Assayer is capable of analyzing 70 samples in an 8- to 10-hour day based on a 240-second analysis time. The instrument is empirically calibrated by the developer. SCITEC requires a 1-day operator training and radiation safety course prior to



MAP® Portable Assayer

obtaining a specific license to operate the instrument. The standard MAP® Portable Assayer package sells for \$15,590.

WASTE APPLICABILITY:

The MAP® Portable Assayer can detect select metals in soil and sediment samples and in filter and wipe samples. It can also detect lead in paint. The MAP® Portable Assayer reportedly can quantitate metals at concentrations ranging from parts per million to percentage levels.

STATUS:

The MAP® Portable Assayer has been used at a number of Superfund sites across the country. It was evaluated in April 1995 as part of a SITE demonstration of FPXRF instruments. The instrument was used to identify and quantify concentrations of metals in soils. A preliminary evaluation of the results yielded field-based method detection limits, accuracy, and precision data from the analysis of standard reference materials and performance evaluation samples.

Comparability of the FPXRF results to an EPA-approved reference analytical method was also assessed during the demonstration. An EPA SW-846 method for FPXRF analysis of soils was published in 1996. A comprehensive evaluation of all results will be presented in a technical report from EPA in 1997.

FOR FURTHER INFORMATION:

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SENTEX SYSTEMS, INC.
(Scentograph Plus II Portable Gas Chromatograph)

TECHNOLOGY DESCRIPTION:

The Scentograph Plus II portable gas chromatograph is designed to monitor volatile organic compound (VOC) emissions from hazardous waste sites and other emission sources. It operates by drawing air through a sorbent bed, followed by rapid thermal desorption into the carrier stream. The instrument operates in either argon ionization or electron-capture modes.

The Scentograph Plus II portable gas chromatograph can operate for several hours on internal batteries and has internal carrier gas and calibration tanks. It can be fitted with capillary columns (30 meters, 0.32 or 0.53 millimeter) or packed columns. The instrument can be operated isothermally at temperatures ranging from ambient to 179 °C. Oven temperatures can be programmed

at a desired rate. The 11.7- electron-volt ionization energy allows a detection limit of about 1 part per billion. The instrument is controlled by a detachable IBM personal computer or compatible laptop computer (see figure below).

WASTE APPLICABILITY:

The Scentograph Plus II portable gas chromatograph can monitor VOC emissions from hazardous waste sites and other emission sources.

STATUS:

The Scentograph Plus II portable gas chromatograph was evaluated in January 1992 at a Superfund site under remediation. Results from this demonstration are presented in a



Scentograph Plus II Portable Gas Chromatograph

peer-reviewed article titled "Evaluation of Portable Gas Chromatographs" in the *Proceedings of the 1993 U.S. EPA/Air and Waste Management Association International Symposium*, VIP-33, Volume 2, 1993.

The technology was also evaluated in June 1994 at a landfill adjacent to a residential area. Results from this demonstration are presented in a peer-reviewed article titled "On-Site Monitoring of Vinyl Chloride at Parts Per Trillion Levels in Air" in the *Proceedings of the 1995 U.S. EPA/Air and Waste Management Association International Symposium*, VIP-47, Volume 1, 1995.

The Scentograph Plus II portable gas chromatograph was also evaluated during a field study in August 1995. During the study, downwind vapors from an artificial source generator were analyzed. Preliminary results of the demonstration were presented in an article titled "Performance Comparison of Field-Deployable Gas Chromatographs with Canister TO-14 Analyses" in the *Proceeding of the 1996 U.S. EPA/Air and Waste Management Association International Symposium*, VIP-64, 1996.

FOR FURTHER INFORMATION:

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SRI INSTRUMENTS (Compact Gas Chromatograph)

TECHNOLOGY DESCRIPTION:

The SRI Instruments (SRI) line of compact single- and dual-oven, portable gas chromatographs (GC) are economical laboratory instruments designed for on-site analysis of organic compounds. SRI GCs are equipped with temperature-programmable column ovens and electronic pressure control of all system gases. These GCs also include built-in, serially interfaced data acquisition hardware and software that permit use of IBM®-compatible desktop, notebook, and palmtop PCs. Windows-compatible software is also available in 16- and 32-bit versions. SRI GCs accept both packed and capillary columns and may be equipped with multiple injectors and detectors for series or independent operation. Purge-and-trap, thermal desorption, gas sampling,

split-splitless, and liquid autosampling systems are available. SRI also manufactures external detector units that may be connected by a heated transfer line to existing GCs.

WASTE APPLICABILITY:

The SRI GCs can monitor airborne emissions from hazardous waste sites and other emission sources before, during, and after remediation. They can also analyze soil, water, and gas samples for organic contaminants such as benzene, toluene, ethylbenzene, xylene, polychlorinated biphenyls, and pesticides. Their performance characteristics in the field have been proven by a large private, commercial, and government user base.



Compact Gas Chromatograph

STATUS:

The SRI model 8610 GC was evaluated in January 1992 at a Superfund site under remediation. Results from this demonstration are presented in a peer-reviewed article entitled "Evaluation of Portable Gas Chromatographs" in the *Proceedings of the 1993 U.S. EPA/Air and Waste Management Association International Symposium*, VIP-33, Volume 2, 1993.

FOR FURTHER INFORMATION:

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STRATEGIC DIAGNOSTICS, INC.
(formerly ENSYS ENVIRONMENTAL PRODUCTS, INC.)
(PENTA RISc Test System)

TECHNOLOGY DESCRIPTION:

The PENTA RISc Test System is designed to quickly provide semiquantitative results for pentachlorophenol (PCP) in soil and water samples. The system is shown in the photograph below.

The technology uses immunoassay chemistry to produce compound-specific reactions that detect and quantify PCP. Polyclonal antibodies are fixed to the inside wall of a test tube, where they offer binding sites for PCP. An enzyme conjugate containing a PCP derivative is added to the test tube to compete with sample PCP for antibody binding sites. Excess sample and enzyme conjugate are washed from the

test tube. Reagents are then added to the test tube to react with the enzyme conjugate, forming a color. After a designated time period, a solution is added to the test tube to stop color formation. The sample color is compared to the color formed by a PCP standard. A differential photometer compares the colors. The results obtained from soil samples are compared against a standard to determine the detection levels.

The system can be affected by extremes of naturally occurring matrix effects such as humic acids, pH, or salinity. Site-specific matrix effects that can affect the system include PCP carriers such as petroleum hydrocarbons or solvents; and other chemicals used



PENTA RISc Test System

in conjunction with PCP, including creosote, copper-chromium-arsenate, or herbicides. Specific chemicals similar in structure to PCP can provide positive results, or cross reactivity.

WASTE APPLICABILITY:

The PCP immunoassay measures PCP concentrations in soil and water. For semiquantitative soil analysis, the concentration ranges are as follows: greater than 50 parts per million (ppm), between 50 and 5 ppm, between 5 and 0.5 ppm, and less than 0.5 ppm. For water analysis, the concentration ranges are as follows: greater than 5,000 parts per billion (ppb), between 5,000 and 500 ppb, between 500 and 5 ppb, and less than 5 ppb. These ranges can be customized to a user's needs.

STATUS:

The SITE demonstration occurred in summer 1993 at Morrisville, North Carolina. Samples collected from Winona, Missouri were transported to the demonstration location for testing. Samples from both sites were analyzed to evaluate the effects of different sample matrices and of different PCP carriers such as diesel fuel and isopropyl ether-butane. During the demonstration, the PENTA RISc Test System analyzed 112 soil samples and 16 water samples. The Innovative Technology Evaluation Report (EPA/540/R-95/514), which details results from the demonstration, is available from EPA.

The PENTA RISc Test System has been accepted under Solid Waste Method 4010 (SW-846, third edition, second update). In the 4 years that it has been available, more than 12,000 immunoassay-based tests have been used on wood preserving sites.

FOR FURTHER INFORMATION:

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STRATEGIC DIAGNOSTICS, INC.
(formerly OHMICRON CORPORATION)
(RaPID Assay®)






TECHNOLOGY DESCRIPTION:

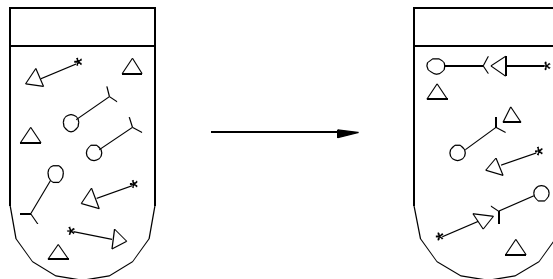
The RaPID Assay® kit is designed to quickly provide quantitative results for pentachlorophenol (PCP) concentrations in soil and water samples. The kit uses immunoassay chemistry to produce detectable and quantifiable compound-specific reactions for PCP. Polyclonal antibodies bound to paramagnetic particles are introduced into a test tube where they offer binding sites for PCP. An enzyme conjugate containing a PCP derivative is added to the test tube, where it competes with PCP from samples for antibody binding sites. A magnetic field is applied to each test tube to hold the paramagnetic particles containing PCP and enzyme conjugate, while excess sample and enzyme conjugate are washed from the test tube.

Reagents are then added to the test tube, where they react with the enzyme conjugate and form a color. The color formed in the sample is compared to the color formed by PCP calibration standards. The comparison is made with a spectrophotometer. Samples with PCP concentrations above the calibration range can be diluted and reanalyzed.

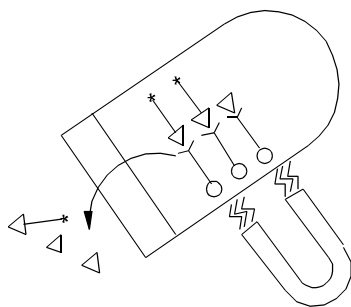
The RaPID Assay® kit has several advantages and limitations when used under field conditions. The method is field portable, easy and fast to operate, and inexpensive. The RaPID Assay® kit is limited in that (1) electricity is required to operate the spectrophotometer, (2) the immunoassay method may be affected by temperature fluctuations, and (3) cross-reactivity may occur for compounds similar to PCP.

Legend

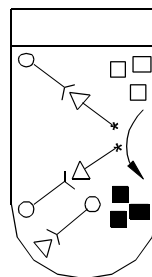
-  Magnetic Particle with Antibody Attached
-  Pentachlorophenol Enzyme Conjugate
-  Pentachlorophenol
-  Chromogen/Substrate
-  Colored Product



1. Immunological Reaction



2. Separation



3. Color Development

RaPID Assay®

WASTE APPLICABILITY:

The RaPID Assay® kit can be used to identify and quantify PCP in soil and water samples. The developer reports the detection limit for soils at 0.1 part per million and water samples at 0.06 part per billion.

STATUS:

The RaPID Assay® kit was evaluated during a SITE field demonstration in Morrisville, North Carolina in August 1993. In addition, samples collected from a location in Winona, Missouri were analyzed to evaluate the effects of different matrices and PCP carriers. The Innovative Technology Evaluation Report (EPA/540/R-95/514), which details results from the demonstration, is available from EPA.

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RaPID Assay Used During the SITE Demonstration

TN SPECTRACE **(TN 9000 and TN Pb X-Ray Fluorescence Analyzers)**

TECHNOLOGY DESCRIPTION:

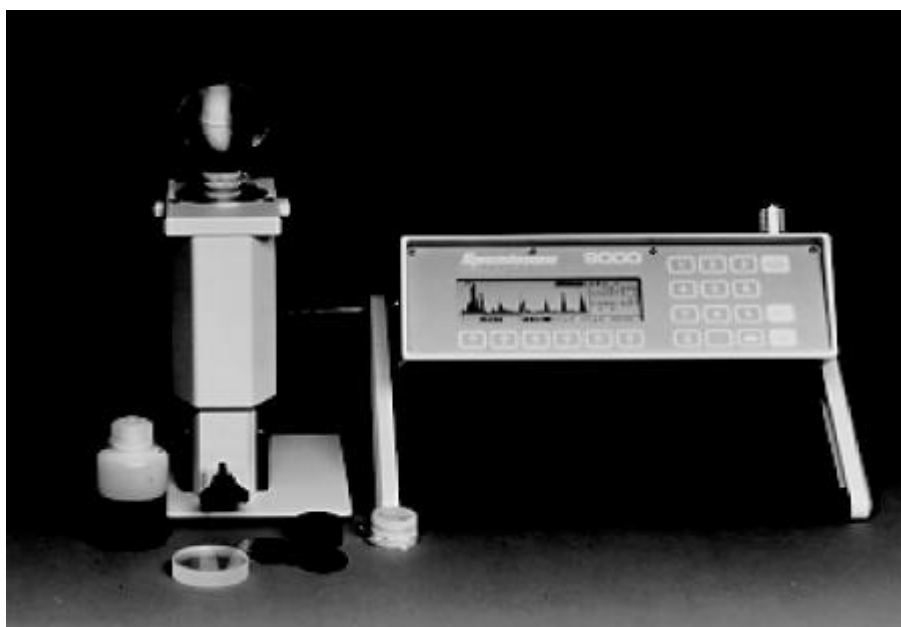
The TN 9000 X-ray fluorescence (XRF) Analyzer is a field portable unit that simultaneously analyzes elements ranging from sulfur to uranium. The TN Pb Analyzer was designed to analyze for lead in soil, paint and paint chips, and other matrices. It can also measure arsenic, chromium, iron, copper, manganese, and zinc in soils. Both instruments are compact, lightweight, and do not require liquid nitrogen. A rechargeable battery allows the XRF analyzers to be used at remote sites where electricity is unavailable.

The TN 9000 analyzer and the TN Pb Analyzer both use a high-resolution mercuric iodide detector to provide elemental resolution and low detection limits. The TN 9000 analyzer is equipped with the three radioisotope sources, iron-55, cadmium-109, and americium-241, which allow for identification and quantitation of 26 elements. The TN Pb Analyzer is equipped only with the cadmium-109 source, which allows for the quantitation and

identification of the seven elements listed above.

The TN 9000 Analyzer and TN Pb Analyzer consist of two main components: a probe and an electronics unit. The probe is connected to the electronics unit by a flexible cable that allows analysis of soil samples in the in situ or intrusive modes. The probe contains the detector and excitation sources and weighs approximately 4 pounds. The electronics unit contains a 2,048- multichannel analyzer (MCA) for spectral analysis. A maximum of 300 sets of results and 120 spectra can be stored in the TN 9000 before downloading to a PC. A maximum of 600 sets of results and 100 spectra can be stored in the TN Lead Analyzer before downloading to a PC.

All elemental concentrations are displayed in parts per million on the LCD of the electronic console. The electronics unit weighs approximately 15 pounds and can be carried in the field in a water-repellant carrying case. The electronic unit is battery-powered and can run up to 8 hours on a full



TN 9000 X-Ray Fluorescence Analyzer

TRI-SERVICES **(Site Characterization and Analysis Penetrometer System [SCAPS])**

TECHNOLOGY DESCRIPTION:

The Tri-Services Site Characterization and Analysis Penetrometer System (SCAPS) was developed by the U.S. Army (U.S. Army Corps of Engineers, Waterways Experiment Station [WES] and the Army Environmental Center [AEC]), Navy (Naval Command, Control and Ocean Surveillance Center), and the Air Force (Armstrong Laboratory). The U.S. Army holds a patent for the application of laser sensors combined with cone penetrometry. The laser-induced fluorescence (LIF) system used in the SCAPS was modified from a design developed by the Navy to detect petroleum, oil, and lubricant fluorescence in seawater.

A complete cone penetrometer (CPT) truck system consists of a truck, hydraulic rams and associated controllers, and the CPT itself. The weight of the

truck provides a static reaction force, typically 20 tons, to advance the CPT. The hydraulic system, working against the static reaction force, advances 1-meter-long, 3.57-centimeter-diameter threaded push rod segments into the ground. The CPT, which is mounted on the end of the series of push rods, contains LIF sensors that continuously log tip stress and sleeve friction. The data from these sensors are used to map subsurface stratigraphy. Conductivity or pore pressure sensors can be driven into the ground simultaneously. The 20-ton truck is designed with protected work spaces.

The SCAPS has been modified to provide automatic grouting of the penetrometer hole during retraction of the CPT. It can also decontaminate the push rods as they are retracted from the soil. The 20-ton CPT system is capable of pushing standard push rods to depths of approximately 50 meters.



Site Characterization and Analysis Penetrometer System (SCAPS)

The main LIF sensor components are as follows:

- Nitrogen (N₂) laser
- Fiber optic cable
- Monochromator to resolve the fluorescence emission as a function of wavelength
- Photodiode array (PDA) to detect the fluorescence emission spectrum and transduce the optical signal into an electrical signal
- OMA to interface between the optic system and the computer system
- Computer system

To operate the SCAPS LIF sensor, the CPT is positioned over a designated penetration point. The LIF sensor response is checked using a standard rhodamine solution held against the sapphire window; sensor response is checked before and after each penetration. The CPT is then advanced into the soil.

The SCAPS LIF system is operated with a N₂ laser. The PDA accumulates the fluorescence emission response over 10 laser shots, and the PDA retrieves an emission spectrum of the soil fluorescence and returns this information to the OMA and computer system. The LIF sensor and stratigraphy data collection are interpreted by the on-board computer system.

The spectral resolution of the LIF system under these operating conditions is 2 centimeters. The fluorescence intensity at peak emission wavelength for each stored spectrum is displayed along with the soil classification data.

WASTE APPLICABILITY:

The Tri-Services SCAPS was designed to qualitatively and quantitatively identify classes of petroleum, polynuclear aromatic hydrocarbon, and volatile organic compound contamination in subsurface soil samples.

STATUS:

The technology field demonstration was held in EPA Region 7 during September 1994. The Innovative Technology Evaluation Report (EPA/540/R-95/520) is available from EPA.

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**UNITED STATES ENVIRONMENTAL
PROTECTION AGENCY**
(Field Analytical Screening Program PCB Method)

TECHNOLOGY DESCRIPTION:

The field analytical screening program (FASP) polychlorinated biphenyl (PCB) method uses a temperature-programmable gas chromatograph (GC) equipped with an electron-capture detector (ECD) to identify and quantify PCBs in soil and water. Gas chromatography is an EPA-approved method for determining PCB concentrations. The FASP PCB method is a modified version of EPA SW-846 Method 8080.

In the FASP PCB method for soil samples, PCBs are extracted from the samples, injected into a GC, and identified and quantified with an ECD. Chromatograms for each sample are compared to the chromatograms for PCB standards. Peak patterns and retention times from the chromatograms are used to identify and quantify PCBs in the soil sample extract. In addition to the GC, the operator may use an autosampler that automatically injects equal amounts of the sample extract into the GC column. The autosampler ensures that the correct amount of extract is used for each analysis and allows continual analysis without an operator.

The FASP PCB method quickly provides results with statistical accuracy and detection limits comparable to those achieved by formal laboratories. The method can also identify individual Aroclors.

Instrumentation and equipment required for the FASP PCB method are not highly portable. When mounted in a mobile laboratory trailer, however, the method can operate on or near most sites relatively easily. Use of this method requires electricity, and Aroclor standards require refrigeration. An exhaust hood and carrier gases also are needed.

Soil samples must be extracted before analysis begins. Hexane and sulfuric acid are used during the extraction process, which removes potential interferences from the soil sample.

WASTE APPLICABILITY:

The FASP PCB method can identify and quantify PCBs in soil and water samples.

STATUS:

The FASP PCB method was demonstrated under the SITE Program at a well-characterized, PCB-contaminated site. During the demonstration, the method was used to analyze 112 soil samples, 32 field duplicates, and two performance evaluation samples. Split samples were submitted to an off-site laboratory for confirmatory analysis by SW-846 Method 8080. Data generated by the FASP PCB method were directly compared with the data from the off-site laboratory to evaluate the method's accuracy and precision. In addition, the operational characteristics and performance factors of the FASP PCB method were evaluated. The Innovative Technology Evaluation Report (EPA/540/R-95/516) is available from EPA.

FOR FURTHER INFORMATION:

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XONTECH INCORPORATED (XonTech Sector Sampler)

TECHNOLOGY DESCRIPTION:

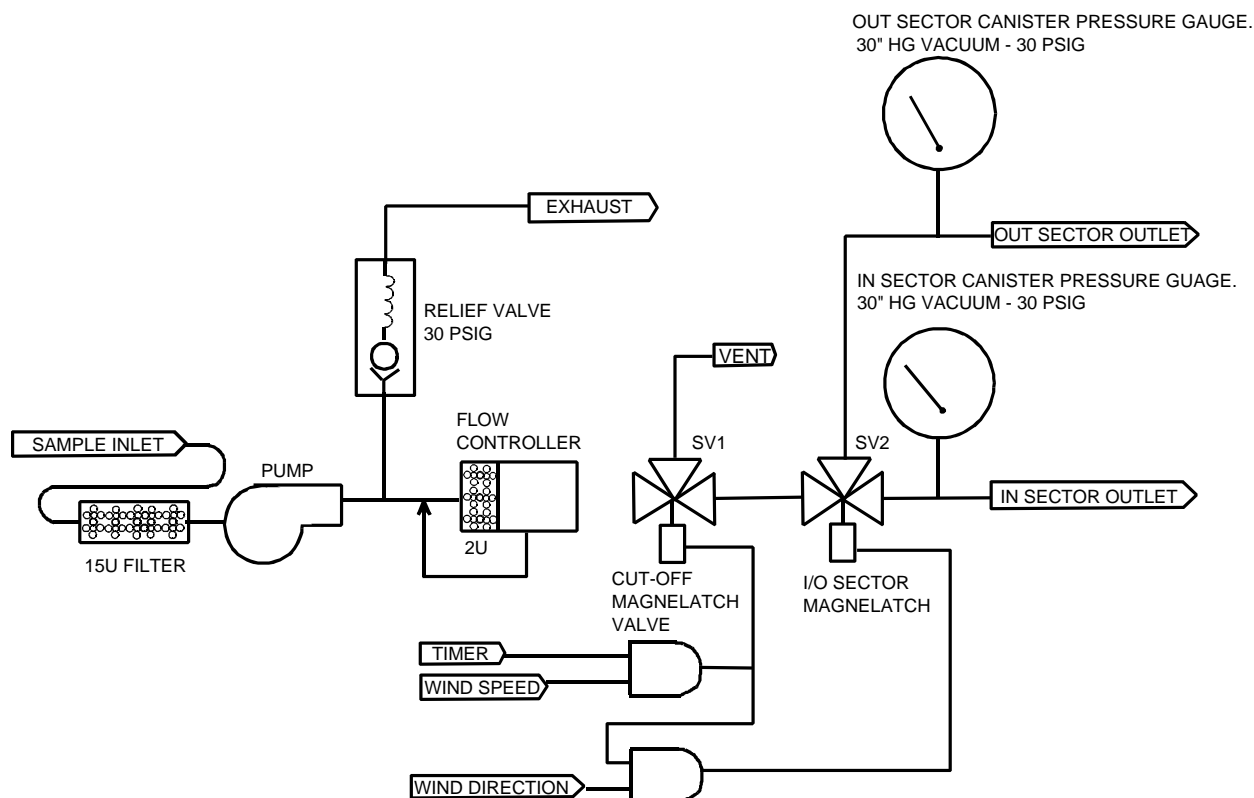
The XonTech Incorporated (XonTech) sector sampler collects time-integrated whole air samples in Summa™-polished canisters. The wind sensor directs whole air, sampled at a constant rate, into either an "in" sector canister or an "out" sector canister. When wind velocity exceeds 0.37 meter per second (m/s) from the direction of the suspected emissions area (the target), the first canister is filled. When the wind velocity exceeds 0.37 m/s from any other direction, the other canister is filled. When the wind velocity falls below 0.37 m/s, either canister or neither canister may receive the sample. Over an extended period of time, a target sample and a background sample are collected. This method is analogous to upwind-downwind sampling but does not require two distinct sites or manual sampler

control.

The sampler is portable and can be battery- or AC-powered. The air samples are analyzed by gas chromatograph (EPA Method TO-14) for volatile organic compounds (VOC). The use of sector samplers enables identification of VOCs originating from the source and differentiation between other sources in the vicinity.

WASTE APPLICABILITY:

The XonTech sector sampler can monitor VOC emissions from hazardous waste sites and other emission sources before and during remediation. Short-term sampling can determine which high concentration compounds are emitted from a site. Long-term monitoring can assess an emission



Schematic Diagram of the XonTech Sector Sampler

source's potential effects on the local population, providing data to support risk analyses.

STATUS:

The XonTech sector sampler's usability has been demonstrated in two short-term field studies. This technology has been applied to industrial emissions as well as emissions from landfill sites. Mathematical methods for processing data have been developed and shown to be appropriate. The sampler is now commercially available.

FOR FURTHER INFORMATION:

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charge.

Both instruments incorporate user-friendly, menu-driven software to operate the instrument. The TN 9000 Analyzer and TN Pb Analyzer are calibrated using fundamental parameters, which is a standardless calibration technique. At the time of the SITE demonstration, the TN 9000 and TN Pb Analyzers cost \$58,000 and \$39,500, respectively. These costs included all equipment necessary to operate the instrument. Leasing and rental options are also available. The TN 9000 Analyzer, using all three excitation sources, is capable of analyzing 100 samples per day. The TN Pb Analyzer is capable of analyzing 300 samples per day using a 60-second count time for the cadmium-109 source.

WASTE APPLICABILITY:

The TN 9000 and Pb Analyzers can detect select elements in soil, sediment, filter, and wipe samples. The TN Pb Analyzer can also detect lead in paint. Both units can identify select elements at concentrations ranging from parts per million to percentage levels in soil samples obtained from mining and smelting sites, drum recycling facilities, and plating facilities. These instruments can provide real-time, on-site analytical results during field screening and remediation operations. XRF analysis is faster and more cost-effective compared to conventional laboratory analysis.

STATUS:

The TN 9000 and TN Pb Analyzers were demonstrated under the SITE Program in April 1995. The instruments were used to identify and quantify concentrations of metals in soils. A preliminary evaluation of the results yielded field-based method detection limits, accuracy, and precision data from the analysis of standard reference materials and performance evaluation samples.

Comparability of the XRF results to an EPA-approved reference laboratory method was also assessed. An EPA SW-846 method for XRF analysis of soils is scheduled to be published in 1996. A comprehensive evaluation of all results will be presented in a technical report from EPA in 1997.

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